The Philippine
Agriculturist

(University of the Philippines Publications: Series A)

VOLUME XXIII

JUNE, 1934 TO MARCH, 1935

(Complete in ten numbers)

PUBLISHED BY
THE COLLEGE OF AGRICULTURE
UNIVERSITY OF THE PHILIPPINES

CONTENTS

VOLUME XXIII

JUNE, 1934 TO MARCH, 1935
(Complete in ten numbers)

NUMBER 1, JUNE, 1934

NUMBER 2, JULY, 1934

NUMBER 3, AUGUST, 1934

NUMBER 7, DECEMBER, 1934

NUMBER 8, JANUARY, 1935

NUMBER 9, FEBRUARY, 1935

NUMBER 10, MARCH, 1935

ERRATA

Page 3, line 10 from top "professor of plant pathology" should read "associate professor of plant pathology."

Page 3, line 18 from top "Dr. J. S. Camus" should read "Mr. J. S. Camus."

Page 131, line 5 from top "*Ceiba pentandra* (L.) Gaertin," should read "*Ceiba pentandra* (L.) Gaertn."

Page 338, line 21 from top "Pechay (*Brassica cernua* F. and H.)" should read "Pechay (*Brassica integrifolia* [West.]) O. E. Schulz.

Page 338, line 16 from bottom "*Diospyros discolor* Wm." should read "*Diospyros discolor* Willd."

Page 338, line 14 from bottom "*Lagenaria leucantha* Rby." should read *Lagenaria leucantha* (Duch.) Rusby."

Page 338, line 13 from bottom "sitao (*Vigna sinensis* var. *sesquipedalis* Fruw.)" should read "sitao, *Vigna sinensis* (Linn.) Savi."

Page 338, line 14 from bottom "patola (*Luffa acutangula* Rxb.)" should read "patola (*Luffa acutangula* Roxb.)"

Page 342, line 21 from top "Balukanag (Tag.), *Chisocheton cummingianus* (C.Dc.) Harms." should read "Balukanag (Tag.), *Chisocheton cumingianus* (C. DC.) Harms."

Page 342, line 25 from top "Dudra (Bicol), *Hydnocarpus alcalae* (C. Dc.)" should read "Dudra (Bicol), *Hydnocarpus alcalae* C. DC."

Page 344, line 9 from top "(*Barrintonia asiatica* Linn.)" should read "(*Barringtonia asiatica* [Linn.] Kurz)"

Page 386, line 8 from top "*Psenderanthemum*" should read "*Pseuderanthemum*."

Page 386, line 11 from top "*Thumbergia*" should read "*Thunbergia*"

Page 387, line 13 from top "*Desmodium capitatum* Burm. f." should read "*Desmodium capitatum* (Burm.f.) DC."

Page 387, line 14 from top "*Indigofera hendecaphilla* Jacq." should read "*Indigofera hendecaphylla* Jacq."

Page 404, line 2 from top "*Fimbrystilis camplanata*" should read "*Fimbristylis complanata*".

Page 408, line 19 from top "*Fimbrystilis annua*" should read "*Fimbristylis annua*."

Page 415, line 3 from top "*Vigna sinensis* (Linn.) Savi ex Hassk" shoud read "*Vigna sinensis* (Linn.) Savi."

Page 451, line 9 from top "*Amorphophalus campanulatus* (Roxb.) Blume ex Deene" should read" *Amorphophallus campanulatus* (Roxb.) Blume."

Page 453, line 5 from top "*Vigna sinensis* L." should read "*Vigna sinensis* (Linn.) Savi."

Page 453, line 14 from bottom "(*Ipomea triloba* Linn.)" should read "(*Ipomoea triloba* Linn.)"

Page 453, line 8 from bottom "(*Andropogon halepensis* var. *propinquus* Kunth)" should read "(*Andropogon halepensis* var. *propinquus* [Kunth] Merr.)"

Page 454, line 1 from top "*Imperata cylindrica* var. *Koenigli* (Retz.) Benth. ex Pilger" should read "*Imperata cylindrica* var. *koenigii* (Retz.) Benth."

Page 454, line 20 from top delete Napier grass after (*Pennisetum purpureum* Schum.)

Page 454, line 16 from bottom "*Operculina turpethum* (Linn.)" should read "*Operculina turpethum* (Linn.) S. Manso".

Page 455, line 5 from top "(*Synedrella nodiflora* Linn.)" should read "(*Synedrella nodiflora* (Linn.) Gaertn.)"

Page 545, line 7 from top "*Vigna sinensis and*" should read "*Vigna sinensis* and"

Page 885, line 9 from top "*Puccinia tubulosa* drawn free hand from sections" should read "*Puccinia tubulosa* drawn from free hand sections".

Page 886, line 1 from bottom delete "the" after "so that the"

Page 895, line 9 from bottom "*Hygomyces haematococcus* (B. & Br.) Wr." should read "*Hypomyces haematococcus* (B. & Br.) Wr."

Page 906, line 8 and line 11 from top "*Aeiginetia indica*" should read "*Aeginetia indica*".

THE NATIONAL RESEARCH COUNCIL OF THE PHILIPPINE ISLANDS [1]

On Friday, March 23, 1934, in the Auditorium of the School of Hygiene and Public Health of the University of the Philippines, the Hon. Jorge B. Vargas, Acting Secretary of Agriculture and Commerce, called to order a meeting of all ad-interim Charter Members of the National Research Council of the Philippine Islands in accordance with Act No. 4120 creating this body approved on December 8, 1933. One hundred five members out of one hundred fourteen appointed by the Governor General answered the roll call.

The Governor General then addressed the members, pointing out to them the nature of their task. In his words "this body can orient life bravely for us in research, in discovering our natural resources in the Philippines." The Governor General then extended congratulations and best wishes to the Council and pledged the cooperation of the executive branch of the government in the furtherance of its work.

Following the Governor General's address, Secretary Vargas administered the oath of office to all ad-interim Charter Members present.

After taking the oath a temporary chairman and a temporary secretary were elected.

Dr. Manuel L. Roxas, Commissioner of Research of the Department of Agriculture and Commerce, was elected temporary chairman of the Council and Dr. Patrocinio Valenzuela, Associate Professor of Pharmacy, University of the Philippines, temporary secretary.

Mr. Vargas called Doctor Roxas to the chair and the first business meeting of the body was called to order. A committee of five was then designated to draft the Constitution and By-Laws, and the meeting adjourned.

On April 3, 1934, the Constitution and By-Laws of the Council were approved.

In accordance with the provisions of Section 2 of Act No. 4120, the purpose of the National Research Council are:

---

[1] General contribution from the College of Agriculture No. 400.

(1) In general, to stimulate research in the mathematical, physical, and biological sciences, and in the application of these sciences to engineering, agriculture, medicine, and other useful arts, with the object of increasing knowledge, starting studies of problems of the national defense, and of contributing in other ways to the public welfare.

(2) To survey the larger possibilities of science, to formulate the comprehensive projects of research, and to develop effective means of utilizing the scientific and technical resources of the country for dealing with these projects.

(3) To promote cooperation in research, at home and abroad, in order to secure concentration of effort, minimize duplication, and stimulate progress; but in all co-operative undertakings to give encouragement to individual initiative as fundamentally important to the advancement of science.

(4) To gather and collate scientific and technical information at home and abroad in co-operation with governmental and other agencies and to render such information available to duly accredited persons.

Immediately after the approval of the Constitution and By-Laws the election of officers took place and the following were elected members of the Executive Board:

Members at Large:

Dr. Manuel L. Roxas
Dr. Bienvenido M. Gonzalez
Dr. Patrocinio Valenzuela

Chairmen of Divisions:

Dr. Victor Buencamino, Division of government, foreign and educational relations.
Rev. Miguel Selga, S.J., Division of physical and mathematical sciences.
Dr. Antonio G. Sison, Division of medical and veterinary sciences.
Mr. Angel S. Arguelles, Division of chemical and pharmaceutical sciences.
Dr. Eduardo Quisumbing, Division of biological sciences.
Mr. Arthur F. Fischer, Division of agriculture and forestry.
Mr. Hermenegildo B. Reyes, Division of engineering and industrial research.

Dr. L. B. Uichanco was tied with Dr. Eduardo Quisumbing in the voting for chairman of the Division of biological sciences. The election was later decided by lot by the Executive Board.

The College of Agriculture is prominently represented in the Council. In addition to three alumni members on the Executive Board; Dr. Manuel L. Roxas '11, emeritus professor of agricultural chemistry, Dr. B. M. Gonzalez '13, professor of animal husbandry, and Dr. Eduardo Quisumbing '18, formerly assistant professor of botany, the following members of the faculty are charter members of the Council: Dr. R. B. Espino '15, professor of plant physiology; Dr. F. M. Fronda '19, assistant professor of poultry husbandry; Dr. N. B. Mendiola '14, professor of agronomy; Dr. G. O. Ocfemia '15, professor of plant pathology; Dr. R. L. Pendleton, professor of soils; Dr. F. O. Santos '19, professor of agricultural chemistry; Dr. A. L. Teodoro '18, associate professor of agricultural engineering; Dr. L. B. Uichanco '15, professor of entomology; Dr. Deogracias Villadolid '19, assistant professor of agricultural zoology, and Dr. V. Villegas '13, associate professor of animal husbandry.

Other alumni of the College who are also charter members of the Council are the following: Dr. F. T. Adriano '19, Dr. V. C. Aldaba '15, Dr. J. S. Camus '14, Dr. L. Clemente '17, Dr. F. M. Clara '20, Dr. G. Merino '14, Mr. F. Q. Otanes '18, Mr. D. B. Paguirigan '16, Mr. H. Silayan '17, Dr. N. G. Teodoro '15, Dr. J. P. Torres '19, and Dr. T. Vibar '12.

On April 13, 1934 the Executive Board of the Council elected its permanent officers as follows: Chairman, Dr. Manuel L. Roxas; Vice-Chairman, Dr. B. M. Gonzalez; Secretary-Treasurer, Dr. P. Valenzuela.

B. M. GONZALEZ
Dean, College of Agriculture

An increasing demand for durable goods is characteristic of every progressive society. There are 1700 research laboratories in the country, compared with only 200 ten years ago, and all are turning out new products and new methods of making old ones. At the Exposition of Chemical Industries in New York during the past month 112 products developed since 1930, selected from 700 offered by sixty manufacturers, were on exhibition. The textile industry has developed during the depression run-resistant hosiery, crease-resistant goods, floor coverings fabricated without a loom, elastic yarns and other compounds embodying rubber, and synthetic furs.

Monthly Letter, The National City Bank of New York.

BUD ROT OF COCONUT [1]

G. O. Ocfemia
Of the Department of Plant Pathology

WITH TWO TEXT FIGURES

The disease of the coconut known as bud rot is the most destructive malady affecting this palm. A coconut palm attacked by the disease never recovers. The reason for this is that when the reliable signs which indicate that the coconut is affected with bud rot can be seen, the disease is so far advanced that no surgical operation on the palm can be performed to save it. This condition is very unfortunate, because, as the coconut does not branch, if its only bud is killed the palm stops growing. The diseased plant if left standing in the field is not only useless but it acts as a center from which the rest of the trees around it may become infected.

The bud rot of coconut occurs in Portuguese East Africa, Ceylon, India, Porto Rico, Florida (United States), Malabar, Trinidad, Jamaica, the Philippine Islands and in other countries. In these places bud rot is considered a very destructive disease.

In the Philippine Islands, coconut bud rot was first studied about 1908 when a serious outbreak of this disease occurred in the highland towns of Laguna Province. The disease was spreading very rapidly and the coconut planters were very much alarmed, because their plantations were threatened with destruction. The coconut planters asked the government to assist them in the control of the disease. The first man who was sent by the government to Laguna to study the coconut bud rot situation was Dr. F. W. Foxworthy. After his field study and survey, Doctor Foxworthy prepared a full report containing his recommendations as to the best means to place the disease under control. Nothing, however, was done to carry out the recommendations contained in this report. The coconut bud rot continued to spread unchecked and the coconut planters were much distressed fearing that their plantations would soon be wiped out. Later, Dr. E. B. Copeland, who was connected with the Bureau of Education in Manila was sent to Laguna to

---

[1] Experiment Station contribution No. 953. Circular 2. This circular is a revision of and supersedes mimeographed Circular 2 issued May 20, 1924 and September 20, 1926, revised. Received for publication January 11, 1934.

study the coconut bud rot epidemic. Through the efforts of Doctor Copeland the Provincial Board of Laguna passed on March 13, 1908 an act requiring that all coconut trees infected with bud rot be cut down and burned. The act was suspended for a few months because the Executive Bureau objected to the provisions for putting it into effect. As the disease continued to threaten the plantations with ruin and the coconut planters were willing to co-operate with the government in the eradication of it, the law was reënacted on October 14, 1908 and is still in force. In 1908, Doctor Copeland's report entitled "Bud rot of the coconut" which seems to be the first paper dealing with any plant disease to be published in the Philippines, appeared in the *Philippine Agricultural Review*.

HOW BUD ROT MAY BE RECOGNIZED

If there were a way of telling when a coconut palm is first infected with bud rot it would be possible to remove the infected portion before the disease reached the growing point of the tree. The wound would be disinfected and the tree saved. There is, however, no way known by which the earliest stage of infection may be detected. And, even if this surgical operation were possible the palm might be set so far back that the effort would not pay.

The first visible symptom of the disease may be noted on the youngest and still unexpanded leaf. The young emerging leaf becomes yellowish brown or light brown. The leaf dies because the softer part of its base is completely rotted. A little later the dead leaf may be pulled out of the inclosing leaf sheath. If the diseased palm is allowed to stand the dead youngest leaf is soon broken by the wind and hangs tip downwards between the older leaves (fig. 1). Finally, this leaf falls to the ground. The older leaves may remain green and retain their usual position for several months. Then these leaves mature and fall off and because there are no new leaves being produced the tree soon has a crown of nearly horizontal leaves. These leaves fall off as they mature and finally the trunk is left bare.

The young spathes are rotted in the same manner as the bud. Usually the infection of the cabbage of the coconut does not reach the nuts. The nuts which have reached a diameter of a few centimeters when the tree is attacked hang on the tree until they mature or until the leaves that support them fall off. Frequently, however, the leaves fall off before the nuts are mature. Often young racemes may be found dead when the spathes open. A close exam-

ination of these dead racemes will show that they are invaded by the causal fungus at their bases.

Sometimes, extending across the pinnae, or leaflets of infected trees are rows of dark brown spots (fig. 1). But, usually, these spots

Fig. 1.—A young coconut tree infected with bud rot. The older leaves were removed so as to show the broken young leaf and the spots with gray center and dark brown border which are present on the young leaflets.

are not present. These spots are due to infection by the causal fungus while the leaves are still closed. On account of the rapid growth

of these emerging leaves only localized dead areas, which appear as spots when the leaflets open, are produced on them. These leaf lesions are not characteristic symptoms of bud rot.

When the tender tissues at the bases of the central whorl of leaves are rotted an offensive odor is given off. This odor is very

Fig. 2.—A section representing one-fourth of the cabbage of a coconut attacked by bud rot showing the rotted growing point. The mass of rotting tissues is gray and the border is dark brown.

characteristic of bud rot and is a very reliable sign of this infection. The odor which may be detected at some distance from the infected tree attracts flies and other insects.

If the crown of an infected plant is cut open the cabbage may be seen as a soft gray mass of rotting material (fig. 2). When the

youngest emerging leaf shows the browning, which is the first visible symptom of bud-rot infection, the growing point of the coconut is already rotted. Any surgical operation performed to save the tree at this time will mean the removal of the whole infected cabbage which contains the growing point of the palm.

WHAT CAUSES BUD ROT

The infectious form of bud rot of coconut in Cuba was at first attributed to bacteria, known as *Bacillus coli* (Esch.) Migula (Johnston, 1912). Reinking (1918), working in the College of Agriculture at Los Baños believed at first that the coconut bud rot in the Philippines is also caused by *Bacillus coli.* A year later, however, he showed that the cause of the infectious bud rot in Laguna Province is the fungus [2] called *Phytophthora faberi* Maubl. It is now believed that there are two forms of bud rot. One of the forms is caused by bacteria and the other, the more infectious form, is attributed to *Phytophthora faberi* Maubl. The fungus that causes coconut bud rot causes infection by means of the spores. Its mycelium may also cause infection. Three kinds of spores may be produced. It is not known how the fungus infects the bud of the coconut. Perhaps the spores are carried by wind or insects into injuries produced by insects or the spores are washed down between the leaf sheaths into the cabbage. The fungus *Phytophthora faberi* also causes damping-off and seedling blight of cacao, black rot of cacao pods and stem canker of cacao, canker of Para rubber, root rot and fruit rot of papaya, seedling and shoot blight of various species of citrus and seedling and shoot blight of *Cinchona*, the quinine plant. In India the coconut bud rot is attributed to *Phytophthora palmivora* Butler (1910). In Trinidad one of the types of coconut bud rot present there is said to be caused by *Phytophthora palmivora* Butler (1920). In Porto Rico and Florida, United States, the causal fungus has been identified as *Phytophthora faberi* Maubl. Some authors consider *P. faberi* Maubl. the same as *P. palmivora* Butler and prefer to use the name *Phytophthora palmivora* Butler.

---

[2] There are many plants that are so small that they can be seen only with a powerful magnifying glass. A fungus is one of these very minute plants. It has no green coloring matter with which to manufacture its food so it lives on other plants either while these are living (parasites) or when they are dead (saprophytes). Instead of seeds a fungus produces spores. Its body is made of thread-like filaments known as hyphae or mycelium. As the spores are very small they are easily carried by wind, on the bodies of insects or splashed by rain water, etc.

CONTROL MEASURES

Wherever coconut bud rot occurs extermination or eradication is recommended as the most practical measure. This measure calls for the immediate cutting down of infected trees and complete burning of their crowns. As the coconut does not branch, a tree with the dead emerging leaf which is very characteristic of bud rot infection invariably dies. Such a tree, therefore, should be cut down immediately and its crown burned completely. It is not sufficient just to cut down the trunk of an infected coconut. Its bud is quite as dangerous a source of infection on the ground as it is in the air. The method recommended in various regions where the disease occurs is to cut down all infected trees. Then cut off the tops about 60 centimeters below the leaves and place them in a pile. Whenever possible, gather old stumps of wood, bamboo, dry coconut leaves, coconut husks, dry spathes and debris and place these underneath the diseased tops. Then saturate the diseased coconut tops and the wood and debris underneath with petroleum and set the whole on fire. Burning must be done carefully and with thoroughness because the green tissues of the coconut contain much water and are difficult to burn.

In addition to the measure for exterminating the disease described above every coconut grove should be inspected frequently. The aim of this inspection is to prevent the spread of bud rot from an occasional infection. It is not known to what distance infection may be carried by the wind or other agencies. Neither is it known how the fungous parasite is disseminated and how infection takes place. Probably there is no limit to the distance that the causal fungus may be disseminated by animals or other agencies.

If possible to avoid it, cacao, Para rubber, citrus, papaya and quinine seedlings should not be grown close to coconut groves where bud rot occurs. The fungous parasite of any one of these hosts may be transferred to the coconut and cause bud rot.

It is also a good measure of precaution to burn all coconut rubbish, husks, fallen nuts, leaves and spathes instead of allowing them to rot in the groves. *Phytophthora faberi* is capable of remaining alive on coconut rubbish and other rotting plant materials or waste.

Some people are of the opinion that bud rot is serious in places which are always moist. Others state that the disease is destructive where the palms are planted closer than ten meters each way. The severity of the disease is attributed to the fact that because the air cannot circulate freely the crowns of the palms are always surrounded by moisture. Furthermore, the spread of the disease is

said to be more easily effected when the trees are planted rather close together. Basing his conclusions on these reasons, Reinking (1919) recommends that coconut trees be planted ten meters apart.

As the coconut bud rot fungus grows on a number of cultivated plants it is also possible that it may infect weeds and spend its life cycle on these unnoticed. Keeping the groves clean and well cultivated or planted to intercrops which are known to be free from attack by the fungus is advisable in the control of coconut bud rot.

SUMMARY

The coconut bud rot is the most destructive disease of the coconut in the Philippine Islands. It occurs in many of the coconut-growing countries of the world.

The disease can be recognized by the wilting and yellowing of the youngest leaves. When these first symptoms are seen the growing point of the coconut is already dead and rotted.

The coconut bud rot is caused by a fungus that attacks a number of cultivated plants such as cacao, Para rubber, citrus, papaya and quinine (*Cinchona* spp.).

The disease is controlled by extermination. All infected palms are felled and the crown burned thoroughly because a coconut tree which shows the first symptom of the disease should be considered as dead. A standing diseased palm is not only useless but is a menace because many neighboring palms may become infected from it.

The palms should be planted ten meters apart, the grove kept clean, and if possible to avoid it, no susceptible plants should be planted close to the grove or between the rows of trees. The fungus from the coconut may remain alive on these plants and when conditions become favorable it may be transferred to the coconut and cause bud rot.

REFERENCES

ASHBY, S. F. 1920. Notes on two diseases of the coconut palm in Jamaica caused by fungi of the genus *Phytophthora.* West Indian Bull. 18: 61–73.

BUTLER, E. J. 1910. The bud rot of palms in India. Memoirs of the Department of Agriculture in India 3: 221–280.

COPELAND, E. B. 1908. Bud rot of the coconut. Philippine Agric. Rev. 1: 210–220. *Pl. IV.*

COPELAND, E. B. 1921. The coconut. 2nd rev. ed., xvi + 225 p., 218 fig. London: Macmillan Company Ltd.

JOHNSTON, JOHN R. 1912. The history and cause of the coconut bud-rot. U. S. Dept. Agric., Bur. Plant Indus. Bull. 228: 1–175. *Pl. 1–14.*

REINKING, OTTO A. 1919. *Phytophthora faberi* Maubl.: The cause of the coconut bud rot in the Philippines. Philippine Jour. Sci. 14: 131–151. *Pl. 1–3.*

STUDIES ON THE MORPHOLOGY OF THE MELIACEAE: I. SANDORICUM KOETJAPE (BURM. F.) MERRILL[1]

JOSÉ B. JULIANO
Of the Department of Plant Physiology

WITH SIX PLATES AND ONE TEXT FIGURE

Sandoricum koetjape (Burm. f.) Merr., locally known as *santól* or *santór*, is a cultivated or semicultivated fruit tree in the Philippines, and is often spontaneously abundant in some secondary forests. It is probably an introduced species; it is found also in Siam and Indo-China, and throughout the Malayan region where it is often cultivated (Merrill, 1923-1926). This tree begins to flower in January or even earlier, and the blooming period usually lasts for nearly three months in the College of Agriculture. Fruits are available as late as the early part of September. Its inflorescence is of the paniculate type (fig. 1), which is either axillary or terminal, and arises when new growths begin. The individual flower is borne at the axil of a bract on the individual branchlets of the panicle, and is pale green to greenish white in color, and somewhat fascicled. The calyx is cup-shaped and five-lobed (pl. I, fig. 11). The petals are imbricate in the bud, later spreading in anthesis, more or less oblanceolate, pubescent, rounded at apex, acute at base, and with linear margin. The staminal tube is cylindrical, nearly equalling the petals, hairy inside, toothed towards its apex, the teeth being curved outward at anthesis. The included anthers are usually ten, sometimes less. Near the base of the pistil and enclosing the ovary is a laciniate yellowish disc. The pistil has a large stubby stigma and a long, slender style at the base of which is the 5-celled and 5-carpelled ovary (pl. 1, fig. 15). In each cell are two pendant anatropous ovules or megasporanges, the micropyles of which are superior and are carried at an angle of about 80° (pl. 1, fig. 9). Out of the numerous flowers borne on a single panicle, only a few or one or none at all set fruits, the rest fall early after anthesis.

Our present knowledge of the morphology of this fruit tree is meager, as it is on the family Meliaceae to which this species rightly belongs. The writer has undertaken to present some of its

[1] Experiment Station contribution, No. 954. Received for publication October 23, 1933.

morphological features with the hope that the findings herein reported may throw some light on the cause or causes of the failure of so many of its flowers to set fruits.[2] In this paper are included an account of the development of the floral organs and the gametophytes, and the morphology of the mature fruit and seed.

Literature dealing with the morphology of the family Meliaceae is so limited as to be almost wanting. Out of the twenty-one families given under the Order Geraniales (Engler and Gilg, 1924) only thirteen of them (Schürhoff, 1926 and Schnarf, 1929) have received any morphological attention from botanists.[3]

---

[2] A case where the flowers failed to open at the time of anthesis was brought to the attention of the writer, and a report on it is forthcoming in the near future.

[3] The following are the families under the Order Geraniales as given by Engler and Gilg (1924), and the genera under each family which received some morphological attention as reviewed by Schürhoff (1926) and Schnarf (1929), are given below:

1. Geraniaceae
   Erodium
   Geranium
   Pelargonium
2. Oxalidaceae
   Oxalis
3. Tropaeolaceae
   Tropaeolum
4. Linaceae
   Linum
5. Humiriaceae
6. Erythroxylaceae
   Erythroxylum
7. Zygophyllaceae
   Tribulus
8. Cneoraceae
   Cneorum
9. Rutaceae
   Agathosma
   Citrus
   Coleonema
   Dictamnus
   Esenbeckia (*Polyembryum*)
   Ptelea
   Ruta
   Triphasia
   Xanthoxylon
10. Simarubaceae
    Ailanthus
11. Burseraceae
12. Meliaceae
13. Akaniaceae
14. Malpighiaceae
    Aspicarpa
    Banisteria
    Bunchosia
    Malpighia
15. Trigoniaceae
16. Vochysiaceae
17. Tremandraceae
18. Polygalaceae
    Epirrhizanthes
    Polygala
    Salmonia
19. Dichapetalaceae
20. Euphorbiaceae
    Acalypha
    Alchornea
    Caelebogyne
    Caruncula
    Ceramnthus
    Codiaeum
    Croton
    Euphorbia
    Excoecaria
    Flüggea
    Glochidion
    Hevea
    Manihot
    Mercurialis
    Pedilanthus
    Phyllanthus
    Ricinus
    Securinega
    Trigonostemon
21. Callitrichaceae
    Callitriche

Schürhoff (1926) summarizes the morphological characters of the Order Geraniales as follows: The archesporium is normally one-celled or many-celled in Linaceae and in few species of the Euphorbiaceae. The embryo sac development is of the normal type, that is, four megaspores are formed, the innermost of which gives rise to the eight nucleate megagametophyte. In few of the Euphorbiaceae and Malpighiaceae, however, all of the four megaspores may develop so that we may have a 16-nucleate megagametophyte instead of the normal eight. The embryo sac has ephemeral antipodal cells, and an exception is registered only in the Polygalaceae. Suspensor haustorium is formed in Linaceae, Oxalidaceae, Geraniaceae and Tropaeolaceae. In all cases the male haploid generation is characterized by the presence of three nuclei long before the formation of the pollen tube; in Tropaeolaceae, Malpighiaceae and a few of the Rutaceae and Euphorbiaceae, the mature microspores possess two nuclei. Adventive embryos are known in few of the Euphorbiaceae and in Rutaceae.

MATERIAL AND METHODS [4]

Collection of the material was made from February 21, 1933 to June, 1933 from trees growing by the Campus Bridge and along the road to the Animal Husbandry Department on the College of Agriculture grounds. The material was fixed either in the field or in the laboratory with the use of formalin-acetic-alcohol (70 per cent) prepared according to the formula given by Chamberlain (1932). The small inflorescences and flower buds were fixed *in toto*. The older flowers and fruits were taken singly and slabs were cut off on two opposite sides so as to aid in the rapid penetration of the fixing fluids. The subsequent dehydration and infiltration were as usual, and the material was embedded in paraffin. Considerable difficulty was experienced in cutting older flowers and pericarps because of the presence of numerous trichomes. Sections were cut from six to ten micra thick.

Several stains were used, among which were Heidenhain's ironalum haematoxylin with orange G dissolved in clove oil as a counterstain, Safranin-Delafield's haematoxylin combination, Safranin-Light green, and Heidenhain's ironalum haematoxylin with Safranin.

---

[4] Collections of some of the material was made by Mr. Numeriano L. Cuevas, then employed as Student Graduate Assistant in Plant Physiology; most of the cutting and staining was done by Mr. Proceso E. Alcala, a Graduate Student Assistant in Plant Physiology. Both of these assistants worked under the direct supervision of the writer.

FLORAL DEVELOPMENT

The floral primordium emerges from the axil of a bract on the ultimate branchlet of the paniculate inflorescence as a hemispherical outgrowth consisting of a homogeneous mass of meristematic cells surrounded by a distinct epidermis, and the development of its organs is not strictly *acropetal.* Very soon the first whorl of perianth segments, the sepals, arise simultaneously at the periphery of the floral primordium as five hemispherical masses of cells, which grow rapidly

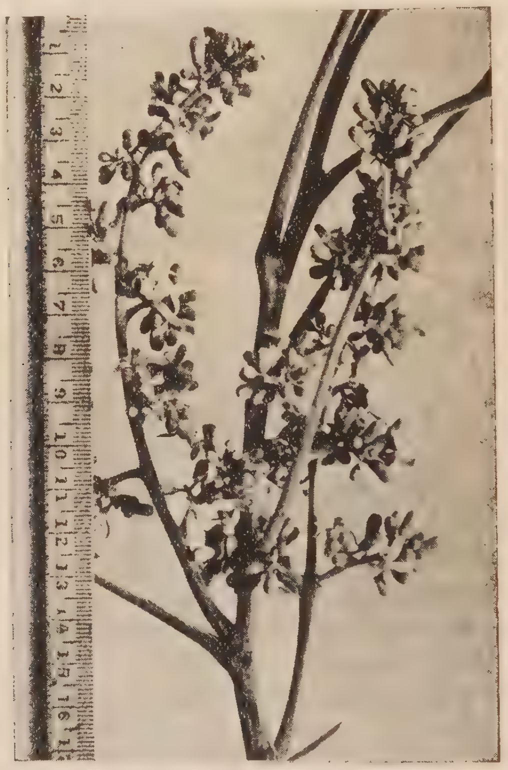


Fig. 1.—Showing inflorescences with a few opened flowers. Photographed March 13, 1933.

and cover the young growing point of the flower (pl. 1, fig. 1). These sepals later fuse to form the cup-shaped calyx to the flower (pl. 1, fig. 11). As soon as the sepals have grown over the apex of the growing point of the floral primordium and their apices overlap, the next whorl of perianth segments, the petals, develops simultaneously as humps of cells within the first whorl of floral envelopes and alternates with their lobes (pl. 1, fig. 2). These petals also grow upward

and bend over the apex of the floral primordium, thus affording the second floral canopy within the first (pl. 1, fig. 3). The development and elongation of the petals, however, is greater than the sepals, and this condition is much more pronounced as the flower reaches maturity. The petals and not the sepals cover the internal organs of the flower until about anthesis (fig. 1).

Scarcely has the petals bent over the growing point of the floral primordium than the ten stamens (pl. 1, fig. 3) differentiate within the second whorl of perianth segments as tubular structures, each opposite each of the calyx and corolla lobes. These young tubular stamens bend over the floral cone (pl. 1, fig. 4), due perhaps to the peculiar arrangement of the perianth segments, but later become erect and early form the short filaments and the terminal, club-shaped, large anthers (pl. 1, fig. 5). The filaments early coalesce (pl. 1, fig. 7), thus forming a cylindrical staminal tube which grows upward, nearly equalling the petals and bearing the nearly sessile anthers near its rim (pl. 1, fig. 11). The rim of the staminal tube is fringed with twenty short, triangular appendages. The next to the last structure to appear on the floral cone are the carpels, which arise as five groups of meristematic cells, each opposite the sepals and within the staminal tube (pl. 1, fig. 4). These individual carpels grow rapidly upward, leaving the central growing point of the floral primordium behind as a flat depression within (pl. 1, fig. 5). The carpels later fuse together at their margins to form the large, stubby stigma, the short but broad style, and the basal ovary (pl. 1, fig. 7). As the flower reaches maturity the style greatly elongates, and at anthesis it becomes slender and very much elongated (pl. 1, fig. 11). Because of the extensive growth of the perianth and staminal tube, the ovary becomes almost buried in the receptacle or torus, but after fertilization it emerges from its sunken condition and becomes much differentiated. The last organ of the flower to appear is the basal disc, which arises between the ovary and the staminal tube (pl. 1, fig. 7) as a thin ring encircling the ovary with its rim fringed like that of the staminal tube. Briefly, the sequence of development of the floral organs in *Sandoricum koetjape* (Burm. f.) Merr. is as follows: sepals, petals, stamens, carpels and disc.

MICROSPOROGENESIS

The anther appears first as a spherical mass of homogeneous cells surrounded by a distinct epidermis. This becomes four-lobed in transverse section and the archesporium differentiates at the lobes quite early. This archesporium consists of two hypodermal cells in

transverse section (pl. 2, fig. 17a), occurring in a longitudinal row. These archesporial cells divide periclinally giving rise to an outer layer of primary parietal cells and an inner layer of primary sporogenous cells. The primary parietal cells by two or more successive periclinal divisions (pl. 2, fig. 18a) form the thin parietal tissue (pl. 2, fig. 18b) consisting of four to five layers of cells. The innermost layer directly in contact with the microspore mother cells functions as the tapetum, while the outermost layer develops the usual rod-shaped thickenings so characteristic of the endothecium (pl. 1, fig. 16). The intervening cells between the tapetum and the endothecium are usually destroyed during the subsequent development of the microspore mother cells. The tapetal cells are very conspicuous and much more so as the microspores enter synapsis. They are uninucleate at first and are binucleate when the microspores are formed (pl. 2, fig. 19) or even earlier, that is, at the time the microspore mother cells are undergoing homotypic division. Binucleate tapetal cells are also found in *Polygala vulgaris* (Schürhoff, 1924), *Mangifera indica* (Juliano and Cuevas, 1932), and *Musa errans* (Blanco) Teodoro var. *botoan* Teodoro (Juliano and Alcala, 1933).

The tapetal cells of *Sandoricum* never give rise to a periplasmodium so characteristic of many species of the Order Geraniales. The appearance of this periplasmodium derived from the tapetal cells has been reported in *Geranium pyrenaicum, Geranium Robertianum, Pelargonium zonale, Polygala vulgaris* and *Euphorbia procera* M. v. B. (*salicifolia*) (Schürhoff, 1924), and in *Geranium silvaticum* L. and *Geranium lividum* (Pers.) L. 'Hér. (Juel, 1915). In *Oxalis acetosella, Linum perenne* L. var. *austriacum, Erythroxylon novogranatense, Tribulus terrester* L., *Ruta graveolens,* and *Callitriche verna* (Schürhoff, 1924) the tapetal cells usually degenerate without the actual formation of periplasmodium similar to that obtaining in *Sandorium koetjape.*

The primary sporogenous cells by a single periclinal division form a group of four microspore mother cells in transverse section (pl. 2, fig. 17b, 18a). In some cases the primary sporogenous cells may not divide at all but function direct as microspore mother cells (pl. 2, fig. 18b).

The microspore mother cell contains a large nucleus with prominent nucleolus (pl. 2, fig. 20). The dense cytoplasm which fills the cell, takes the stains strongly. At synizesis the nucleolus lies at one side of the chromatin knot (pl. 2, fig. 21) and the nucleus becomes distinctly vacuolated. Reduction division is passed very quickly and the division of the microspore mother cell is successive

(pl. 2, fig. 21-24). As the nuclei of the tetrads reach the resting condition, the spindle fibers disappear and these daughter nuclei become separated by walls derived from the ingrowth of the wall of the microspore mother cell, that is, by furrowing. This same formation of walls between the daughter nuclei of the microspore mother cells has been noted in *Tropaeolum majus* L. and *Polygonum savatiere* Nakai (Suguira, 1925, 1925a), and in *Nicotiana* and *Cucurbita* (Schnarf, 1929). The microspores are of the tetrahedral arrangement (pl. 2, fig. 23-24) which are at first embedded in a slimy mass derived from the wall of the mother cell. Later, the gelatinous matrix surrounding the tetrads is destroyed, and the microspores are liberated, each acquiring its own distinct coats.

Shortly after separation and before the coats become appreciably thickened, the microspores are provided with three distinct nuclei (pl. 2, fig. 25a). The vegetative nucleus is large, rhomboid and with distinct nucleoli, while the sperm nuclei are much smaller, oblong to ovoid in shape. These sperm nuclei usually lie at one side (pl. 2, fig. 25a) or on two opposite sides of the vegetative nucleus. In other words, the microspores become trinucleate very early. This trinucleate condition of the microspores is a general characteristic of the Order Geraniales (Schürhoff, 1924) and exceptions are only found in *Oxalis acetosella, Tropaeolum majus, Tropaeolum minus, Linum perenne* L. var. *austriacum, Ruta graveolens, Dictamnus albus* L., *Coleonema album, Ailanthus glandulosa* L., *Malpighia urens* L., *Malpighia coccifera* L., *Bunchosia nitida* (Jacq.) Buchn., and *Flüggea* (*Securinega*) *japonica* (Schürhoff, 1924) and *Euphorbia corollata* (Lyon, 1898).

While the microspores are apparently fertile in many of the flowers so far examined, cases of degeneration are not unknown. Long before dehiscence of the anthers, the microspores start to degenerate. Degeneration begins with the shrinkage of the cytoplasm from the wall (pl. 2, fig. 25b) and this is followed by the disintegration of the nuclei. These nuclei become densely stained and lose their identity. In some mature microspores which appear fertile on account of an abundance of food granules, the vegetative nuclei become degenerated and stained as a blackened mass, while the sperm nuclei could not be located at this time (pl. 2, fig. 26a). In other microspores the conspicuous food granules so characteristic of many fertile microspores are absent, and nothing persists in them except the faintly developed vegetative nucleus and a scanty cytoplasm (pl. 2, fig. 26b). In other words, degeneration of the microspores

starts after their formation as is also true with *Albizzia lebbek* (Maheswari, 1931).

Sterility in some plants has often been ascribed to the failure of the microspores to develop normally as is true of *Daphne odora* (Osawa, 1913) and *Spondias purpurea* Linn. (Juliano, 1932). Fruits are set in *Spondias* and these are considered parthenogenetic and no seeds are developed.

Just before dehiscence the anther possesses a distinct endothecial layer with the characteristic rod-shaped thickenings (pl. 1, fig. 16). The epidermal cells become flattened and sometimes obliterated, while the tapetum is gone, and the parietal tissue is greatly degenerated at this stage of development.

MEGASPOROGENESIS

As the carpels elongate upward to form the style and the stigma, the apex of the floral axis remains as a flat structure within the enclosure of the carpel wall (pl. 1, fig. 5). This central growing point then grows and becomes hemispherical as the carpels are about to fuse (pl. 1, fig. 6). It fills the space formed at the base of the fusing carpels, becoming conspicuously pyramidal in shape at times, and very closely keeps pace with the enlargement of the ovarial cavity (pl. 1, fig. 7). The lateral portions of this outgrowth just facing the individual carpels function as the placentae which send out paired lateral protuberances into each of the loculi of the ovary. Each of these lateral protuberances grows out horizontally at first, each functioning as the nucellus of one of the nascent megasporanges within each of the loculi of the ovary. Similar development of megasporanges has been noted in *Cocos nucifera* Linn. (Juliano, 1926). In the young flower, therefore, are found ten megasporanges (pl. 1, fig. 15), two in each of the loculi. The carpels become completely united at the style (pl. 1, fig. 13) leaving a small hollow within, while at the stigmatic portion they again become distinct, forming a narrow nutritive tissue at the center (pl. 1, fig. 12). Throughout the length of the style and lining the hollow within is a continuous conductive tissue, and this, too, leads to each of the loculi or cells of the ovary through separate masses of highly differentiated conductive cells (pl. 1, fig. 14).

By a regional growth the young megasporange is bent upward (pl. 1, fig. 8) with its micropyle directed at an angle of about 22-23° at which time the inner integument is fully differentiated. Bending of the megasporange continues until it is completely anatropous (pl. 1, fig. 9). At this stage of development its micropyle becomes

superior and is held at an angle of about 80°, and its outer integument is fully developed. In other words, the development of the integuments of the megasporange is basipetal. These integuments are thin and scarcely cover the apex of the nucellus. The outer integument is somewhat thicker than the inner (pl. 4, fig. 58) and the former becomes considerably thicker (pl. 5, fig. 62) as the megasporange develops. The nucellus is massive and consists of a mass of homogeneous cells, delimited by a distinct epidermis.

Very soon a hypodermal cell functioning as an archesporium arises at the summit of the nucellus of the anatropous megasporange. This archesporial cell gives rise to an outer primary parietal cell and an inner megaspore mother cell by a single periclinal wall. A single-celled archesporium seems to be the predominant character of the Order Geraniales, although many-celled archesporium has been reported in *Linum perenne, Linum perenne* L. var. *austriacum,* and *Euphorbia procera* (*salicifolia*) (Schürhoff, 1924). According to Schürhoff (1926) Jönsson also reported many-celled archesporium in *Linum usitatissimum* and *Linum flavum* L., while Modilewski (1910) and Schürhoff (1924) found this to be true also of *Euphorbia procera.* Schürhoff (1924) cites Modilewski as having observed many-celled archesporium in *Euphorbia lucida, Euphorbia virgata* and *Euphorbia palustris.* In *Euphorbia virgata* W. & K. only one of the two to several embryo sac mother cells develop, and this functional embryo sac mother cell forms only three megaspores, the lowermost of which becomes functional.

While the archesporium in the majority of cases functions direct as the megaspore mother cells, in other species belonging to the Order Geraniales a parietal cell is cut off first as is true in *Citrus trifoliata* (Osawa, 1912), *Mercurialis annua* (Schürhoff, 1924), *Euphorbia corollata* (Lyon, 1898), and *Euphorbia procera, E. lathyris, E. salicifolia, E. globosa, E. meloformis, E. cyparissias, E. coralloides, E. variegata, E. helioscopia, E. gerardiana E. ipecacuanha, E. heterophylla,* as well as in *Ricinus communis, Phyllanthus angustifolius, Securinega ramiflora* and *Croton ciliatoglanduliferum* (Modilewski, 1910). In *Malpighia coccifera* L., and *Malpighia urens* L., and *Bunchosia nitida* (Jacq.) Buchn. (Schürhoff, 1924) the archesporium gives rise direct to the embryo sac similar to that reported in *Lilium* (Coulter and Chamberlain, 1903) and *Cocos nucifera* (Quisumbing and Juliano, 1927).

The primary parietal cell together with the epidermis and nucellular cells divide periclinally (pl. 3, fig. 27-28) forming an extensive mass of thick parietal tissue which pushes the megaspore mother

cell way deep in the chalazal portion of the nucellus (pl. 3, fig. 29) as is true of *Euphorbia corollata* (Lyon, 1898). The megaspore mother cell is at first rhomboidal or polygonal in shape with its micropylar end enlarged (pl. 3, fig. 27) and contains a large nucleus and deeply staining cytoplasm. Sometimes it may greatly elongate (pl. 3, fig. 28) before the formation of an extensive parietal tissue by the epidermis and hypodermal cells of the nucellus takes place. After it has been buried in the chalazal end of the nucellus it may become oblong in shape (pl. 3, fig. 29).

The megaspore mother cell undergoes the usual synizesis and diakinesis stages, and after the first division a wall is laid between the two daughter nuclei (pl. 3, fig. 30). The divisions of the megaspore mother cell seem to be very rapid and a row of four megaspores is formed (pl. 3, fig. 31). Out of the four megaspores produced, the lowermost one usually functions (pl. 3, fig. 32 and 35) and forms the seven-celled megagametophyte (pl. 3, fig. 39a and b) so often encountered in many of the Angiosperms. Degeneration of the megaspores starts at the micropylar region (pl. 3, fig. 32, 35 and 36) and proceeds downward. While four megaspores are usually found in the Order Geraniales, Schürhoff (1924) reports that Modilewski and Jönsson found only three megaspores in *Euphorbia virgata* and *Mercurialis annua*, respectively. Modilewski (1910) found that three megaspores are also developed in *Euphorbia meloformis*, and three to four in *Euphorbia coralloides*.

Normally, the proximal megaspore enlarges and its nucleus divides (pl. 3, fig. 36) at the center, the two daughter nuclei early migrating to the poles leaving large central vacuole behind (pl. 3, fig. 37-38). These nuclei never begin to divide until after the embryo sac has enlarged considerably. Subsequent divisions seem to be very rapid as intervening stages were not obtained even when the series collected were plentiful. However, a normal seven-celled megagametophyte is formed.

The mature megagametophyte (pl. 3, fig. 39a and b) contains an egg apparatus, two polar nuclei and three antipodal cells. The sac is more or less pear-shaped with its narrow end toward the micropyle and its enlarged portion directed to the chalaza of the nucellus. Opposite the micropyle is formed a small chalazal socket wherein the antipodal cells are located (pl. 3, fig. 39b). The synergid (pl. 3, fig. 39a) is pyriform in shape, rather long and possesses a distinct basal filiform apparatus only found in *Polygala myrtifolia* (Schürhoff, 1924) within the order, and dense cytoplasm forming a large terminal vacuole opposite the micropyle. Its nucleus is large

and it possesses a quite large nucleolus. The nucleus usually lies in the dense cytoplasm. The synergid may be more persistent than the megagamete (pl. 3, fig. 44) or vice versa (pl. 5, fig. 59) if no fertilization takes place.

The megagamete (pl. 3, fig. 39a) is larger than the synergids and is located between them. It is provided with a scanty, thin cytoplasm at its apical end wherein the small nucleus is embedded. Its basal portion is occupied by a large vacuole (pl. 4, fig. 46).

The polar nuclei usually lie close together just above the egg apparatus (pl. 3, fig. 39a, 42, 45) or one of them may be above one of the synergids and the other, above the megagamete (pl. 3, fig. 46); sometimes they may be found on one side of the egg apparatus at close proximity to the megagamete (pl. 3, fig. 45). The polar nuclei are conspicuously vacuolated and large, each possessing a distinct nucleolus. Associated with them are an abundance of starch grains so conspicuously prominent in the mature sac previous to fertilization. It is very interesting to note that among the species so far examined in the Order Geraniales, *Cneorum tricoccum* (Schürhoff, 1924) is the only one exhibiting polar nuclei at the vicinity of the antipodals.

The antipodal cells (pl. 3, fig. 39b) lie in a basal socket and are triangular to trapezoidal in shape. They have dense cytoplasm and distinct nuclei. Unlike the synergids, the antipodal cells are ephemeral in nature and usually show signs of degeneration long before fertilization. In fact the first constituent of the embryo sac to degenerate in *Sandoricum* are the antipodals. However, in *Cneorum tricoccum, Polygala myrtifolia* and *Polygala vulgaris* (Schürhoff, 1924) the antipodal cells are rather persistent, and a linear arrangement of these antipodals has been observed in *Tribulus terrester* L. (Schürhoff, 1924).

Examination of the megagametopytes at or before the opening of the flower shows the presence of considerable amount of starch grains (pl 3, fig. 39a, 42, 44; pl. 4, fig. 46), usually disappearing after fertilization (pl. 1, fig. 10; pl. 4, fig. 47-48). One slide was stained with tincture of iodine solution and it showed starch grains in abundance in the sac as well as in the lowermost cells of the nucellus. The presence of starch grains in the embryo sac has been reported in peanut (Reed, 1924), alfalfa (Reeves, 1930), *Albizzia lebbek* (Maheswari, 1931), *Theobroma cacao* (Cheesman, 1927), and in many other plants (Dalhgren, 1927). Schürhoff (1924) also found a large amount of starch grains in old unfertilized embryo sacs of *Pelargonium zonale, Geranium Robertianum* and *Geranium*

pyrenaicum. Dahlgren (1927) states that the content of starch in the embryo sac reaches its maximum shortly after fertilization and from that time onward it is more or less rapidly consumed. Maheswari (1931) believes that the occurrence of starch is *Albizzia lebbek* is due to delayed fertilization, as the dissolved carbohydrates coming into the embryo sac can not be used and must be stored temporarily. It is perhaps also true that the accumulation of an abundance of starch in the embryo sacs of *Sandoricum* is indicative of the delay or failure of the megagamete to be fertilized.

In his attempt to find the cause or causes for the early falling of numerous flowers shortly after anthesis and the production of a relatively small number of fruits per floral cluster, the writer has not been disappointed. From the hundreds of flowers examined microscopically, only a few of them exhibited megasporanges producing what may be called normal embryo sacs. The female gametophyte in these flowers show various degrees of degeneration. Degeneration of the female gametophyte seems to start at the tetrad condition. The megaspores may show early degeneration (pl. 3, fig. 34); their cytoplasm shrinks, later losing its identity and the megasporange fails to develop (pl. 5, fig. 61).

Degeneration may also be manifested rather late and the embryo sac thus formed never exhibits its distinctive cell contents (pl. 3, fig. 43). In this sac the antipodals are the only ones differentiated as well as the polar nuclei. The other nuclei in it just wander in the cell and totally fail to form walls around them.

While the upper three megaspores usually degenerate (pl. 3, fig. 36) in *Sandoricum* and the chalazal one becomes functional, the two lowermost megaspores may at times start to function (pl. 3, fig. 33), the product or products of which fail to form the normal megagametophyte. In this figure the third megaspore is even larger than the chalazal one, and it shows all the potentialities of developing further. These two megaspores develop simultaneously, although division of the nuclei of the upper megaspore may proceed ahead of the lower megaspore (pl. 3, fig. 40). In some cases the lower megaspore may be more active than the third megaspore (pl. 3, fig. 41) and more nuclei may be present in the former. In this particular case the micropylar nucleus of the upper cell fails to divide the second time, and consequently only three nuclei are formed. Generally, however, when two megaspores start to function not one of them succeeds in producing a normal eight-nucleate megagametophyte. In one case, however, due perhaps to better nutrition, a seemingly normal embryo sac derived from the third megaspore is formed

(pl. 3, fig. 42), while the lowermost embryo sac shows only four nuclei. The egg apparatus in the upper sac possesses two large synergids with abnormally large nuclei and a megagamete with a distinctly small nucleus. The polar nuclei are undergoing degeneration and are actually much smaller than those of the synergids. The antipodal cells are absent, which may have been not actually formed at all or have degenerated rather early. A comparison with the normal megagametophyte will reveal the following facts: (1) the synergids here show a very faint filiform-apparatus and the distinct terminal vacuole, (2) the megagamete, although possessing dense cytoplasm, has a very poorly developed nucleus, (3) the polar nuclei are much smaller than those found in the normal sac. The lower sac develops a large vacuole and the nuclei, especially those at the micropylar end, are on the way to degeneration, while those at the chalazal end, are just starting to disorganize. At all events, even if one of these megaspores, usually the third, ever succeeds in developing an embryo sac containing an egg apparatus and polar nuclei, the sac thus formed is degenerated compared with the normal one.

In some cases, even if the embryo sac is normal, fertilization does not take place owing perhaps to absence of fertile microspores, and the synergids as well as the megagamete meet a natural death (pl. 5, fig. 59).

Maheswari (1931) believes that the failure to set seeds in *Albizzia lebbek* is due to the degeneration of the microspores and the female haploid generation, and partly to failure in pollination. In the male haploid generation, degeneration sets in actively after the formation of the microspores. In the female gametophyte, degeneration may set in at any stage beginning with the megaspore mother cell stage, but is commonest at the four- and eight-nucleate stages. Any or all of the nuclei of the embryo sac may be involved.

DEHISCENCE AND FERTILIZATION

Dehiscence of the anthers usually takes place normally before anthesis; perhaps the stigmas are receptive then. Numerous flowers fall from the floral cluster after anthesis, causes of which may be attributed to the improper development of the female gametophyte and partly to the formation of defective microspores. The close proximity of the anthers to the stigma (pl. 1, fig. 11) renders autogamy (selfing) possible. However, insects may take part in the transfer of microspores from one flower to another as they are abundant at any time around the blooming tree; besides the flowers in a single cluster never open at the same time (fig. 1).

The pollen tube, perhaps, penetrates the stigmatic surface down into the central portion of the style (pl. 1, fig. 13) where the conductive tissue is present. The pollen tube then grows through the alley leading to the loculi (pl. 1, fig. 14), entering through the micropyle into the nucellus right into the embryo sac. It seems that the tube passes between the synergids without destroying them (pl. 3, fig. 45) and discharges its contents on top of one of the synergids. No actual fusion of gametes or actual discharge of sperms have been noted.

THE FRUIT

The mature fruit of *Sandoricum koetjape* (Burm. f.) Merr. is globose or depressed globose, yellowish outside, rather pubescent, ranging from four to six centimeters in diameter. The outer fleshy portion of the pericarp is rather thick, subacid or acidic in taste, and flesh-colored. The inner fleshy portion of the pericarp is soft, whitish or translucent, somewhat fibrous, sweet, and adhering tenaciously to the shells or stony layers (pl. 5, fig. 66). The fruit is 3- to 5-celled (pl. 1, fig. 15; pl. 5, fig. 60), and each cell is provided with a distinct, thin stony layer or shell, within which are one to two seeds (pl. 5, fig. 66).

After fertilization the petals fall off, and the ovary enlarges and becomes prominently spherical, emerging from the disc and the receptacle. Of the two megasporanges in the cells, normally one of them develops into the seed (pl. 5, fig. 60; pl. 6, fig. 71), although cases where both the megasporanges become functional (pl. 5, fig. 66-68) are not unknown or rare.

Pericarp

At the time the flower is less than four to five millimeters long, the ovary wall appears as a homogeneous mass of parenchymatous, isodiametric cells with palisaded outer and inner epidermal layers. Between this ground parenchymatous cells are distinct large air spaces. No lateral outgrowths or trichomes (pl. 4, fig. 56) are present at this stage of development of the ovary; these trichomes are only found on the perianth segments and on the interior surface of the staminal tube (pl. 1, fig. 11). Lining each of the loculi or cells of the ovary is a distinct epidermis consisting of rectangular cells which are radially elongated (pl. 4, fig. 49).

Epidermis to the loculi. The inner epidermal cells of the pericarp surrounding each of the loculi or cells of the ovary (pl. 1, fig. 15) exhibit very active periclinal divisions at anthesis (pl. 4, fig. 50). The resulting daughter cells similarly divide (pl. 4, fig. 51-52)

and a tissue of many layers of cells is thus developed (pl. 4, fig. 53-54). These layers of cells collectively form the stony layer to each of the loculi. Very soon, differentiation in among these cells of the stony layer takes place. At the time the stony layer is about six layers of cells thick, those cells toward the solid pericarp become very conspicuously elongated and prosenchymatous with their long axes parallel to the circumference of the locule. Those cells abutting the loculi remain iso-diametric or oblong (pl. 4, fig. 51-55). The prosenchymatous cells are much longer than broad. This differentiation becomes prominent as the fruit matures, and much more so at the time lignification is complete (pl. 4, fig. 55). This tissue constitutes the shell or the stony layer to each of the loculi in which the seed or seeds (pl. 5, fig. 66-68) are enclosed and these stony layers or shells are usually five in number (pl. 5, fig. 60) or even fewer in the mature fruit.

Lignification of the stony layer takes place long before maturity of the fruit. Ordinarily, this stony layer enclosing the loculi and whatever it may contain is what is often called the "seed" and this is planted direct to reproduce the species. Strictly speaking this "seed" is not morphologically the seed because the true seed is actually encased inside the shell or stony layer. If it happens, as it does at times, that two megasporanges in the locule develop into seeds, then there will be two distinct seeds in the stony layer or "seed" (pl. 5, fig. 66). If this stony layer with its contents is germinated, two independent plants (pl. 5, fig. 67-68) will sprout from it. This surely gives one an impression of a case of polyembryony so often encountered in *Citrus trifoliata* (Osawa, 1912), *Mangifera indica* Linn. (Juliano and Cuevas, 1932), *Xanthoxylon Bungei* (Schnarf, 1929), *Euphorbia dulcis* (Hegelmaier, 1903), *Alchornea* (*Caelebogyne*) *ilicifolia* (Schürhoff, 1924), *Funkia, Nothoscordon, Euonymus, Clusia, Opuntia* and others (Coulter and Chamberlain, 1903). Apparently, many, of what have been considered cases of polyembryony in this fruit tree as well as in other plants hitherto not worked out morphologically, may be nothing but the result of the development of more than one seed within a shell or stony layer commonly considered the "seed."

Outer epidermis. The outer epidermis of the pericarp (pl. 4, fig. 56) remains palisaded or rectangular in shape with their long axes parallel to the radii of the ovary wall (pl. 4, fig. 57). This palisaded condition of the outer epidermal cells becomes more pronounced at the time the young fruit attains a length of about seven to eight millimeters (pl. 4, fig. 57). Anticlinal divisions of these epi-

dermal cells take place in order to accommodate the enlarging hypodermal cells of the pericarp. Just after anthesis some of the cells of this epidermis elongate radially (pl. 4, fig. 57) and produce either unicellular, or multicellular capitate trichomes. The unicellular trichomes may remain thin-walled but most of them become thick-walled and lignified. The trichomes are devoid of pigment and may remain alive throughout almost the whole time that the fruit hangs on the tree. Some, however, lose their nuclei rather soon. The pigment so characteristic of this fruit pericarp is found almost wholly in the hypodermal cells several layers in thickness below the outer epidermis.

Pericarp. The cells found below the outer epidermis are usually compact (pl. 4, fig. 56-57; pl. 6, fig. 69) and parenchymatous, and these usually become progressively larger and more spongy towards the central portion of the pericarp (pl. 5, fig. 63). These cells again become smaller towards the loculi (pl. 4, fig. 51-54). The cells between the loculi are isodiametric and rather compact. At the axis are groups of vascular bundles. On the ground parenchyma composing the whole pericarp are numerous unicellular to multicellular latex vessels and, vertically directed, abundant vascular bundles. These vascular bundles as well as the latex vessels run perpendicularly in the pericarp and may be branched in any direction.

As the fruit matures, the latex vessels lose their contents and this latex is almost gone at the time the fruits naturally fall from the tree. Lignification of the vascular elements is very slight in the outer portion of the pericarp, and is almost absent in the soft, white or translucent, fibrous edible inner portion.

When the young fruit is about four centimeters in diameter the hypodermal cells around the stony layers or shells elongate radially (pl. 5, fig. 65; pl. 6, fig. 70) and become tubular and thin-walled. Their elongation may be so extensive that the cells actually appear similar to fungal hyphae (pl. 6, fig. 72). Elongation of these pericarp cells proceeds outward from the shells or stony layers until nearly half of the pericarp wall becomes involved; between the loculi all the cells become elongated except the central vascular bundles and the scattered bundles in the pericarp (pl. 5, fig. 64). This soft, juicy, white or translucent sweet edible portion surrounding each of the shells or stony layers, or "seeds" is, therefore, the inner half of the pericarp. Those pericarp cells directly surrounding the stony layers may remain nearly isodiametric and at times may show slight lignification at maturity of the fruit. These cells attach this edible portion to the stony layers.

The remaining outer portion of the pericarp persists as a solid mass of large, loosely packed, oblong to isodiametric, thin-walled cells many of which possess tannin. The latex vessels lose their content and appear as long ramified canals. The hypodermal cells usually contain the characteristic yellow color of the fruit. This outer portion of the pericarp easily separates from the inner softer portion which adheres to the shell and forms the thick, yellowish or flesh-colored skin to the fruit.

THE SEED

The seed of *Sandoricum koetjape* (Burm. f.) Merr. is rather large, more or less triangular in transverse section with its abaxial side rounded. Usually a single seed is formed in each locule, but two seeds are not uncommonly encountered in it (pl. 5, fig. 66). The seed or seeds become surrounded by a thin stony layer or shell derived from the inner epidermis of the pericarp and this bears the translucent or pale white, edible, acidic or sweetish inner half of the pericarp. The seed bears two distinct coats: namely, the *testa* and the *tegmen*. The testa is usually tough, thick, and brownish in color while the tegmen is whitish and papery to the touch. The embryo consists of two plano-convex cotyledons between which are the small stubby radicle and the plumule.

Endosperm. The endosperm of *santól* is of the nuclear type as is usually found among many of the species in the Order Geraniales. The primary endosperm nucleus actively undergoes divisions soon after fertilization and forms numerous free endosperm nuclei in the sac. These nuclei later take a peripheral position leaving a large central vacuole (pl. 1, fig. 10). Wall formation takes place first at both poles from where it proceeds towards the center until the whole sac is completely filled with it. This extensive endosperm is, however, absorbed completely by the developing embryo and is totally absent in the mature seed.

In *Linum perenne* Linn. var. *austriacum* and *Linum flavum* Linn. (Schürhoff, 1924) the endosperm is also nuclear, but a basal apparatus is developed in each. In *Linum usitatissimum* var. *hungaricum* (Schürhoff, 1924) a wall is laid down after the first division of the primary endosperm nucleus, and in both basal and upper endosperm cells free nuclear divisions take place. The upper endosperm cell later becomes cellular, while the lower remains multinucleate and functions as a haustorium. A complete deviation from the whole group is reached by *Callitriche verna* L. (Schürhoff, 1924) where a true cellular endosperm is developed.

Embryo. The zygote usually enlarges after fertilization and remains nearly spherical (pl. 4, fig. 47). It stays dormant for a long while, and only divides long after endosperm formation has been under way. Its first division, which usually takes place when the fruit is about seven to eight millimeters long, is transverse (pl. 4, fig. 48), and a large basal cell and a small apical cell are formed. The account of the further development of this proembryo can not be given here because of the scanty material on hand. However, at maturity of the seed the embryo, which lies parallel to the long axis of the seed, consists of a strongly developed radicle and plumule, both lying between a pair of plano-convex cotyledons which completely absorb the endosperm.

Seed coats. The young megasporange possesses two integuments (pl. 4, fig. 58), the outer possessing three to four layers of cells, and the inner, only two layers. As the megasporange increases in size the inner integument becomes massive at its apex and in time covers the apical portion of the nucellus forming a small micropylar canal. The outer integument, however, remains thin for some time, but later increases considerably in thickness (pl. 5, fig. 62).

(*1*) *Outer coat or testa.* The outer integument outgrows the inner integument after fertilization and becomes very massive, especially at the region about the funiculus (pl. 1, fig. 10). This consists of small to large parenchymatous cells which become spongy at the time the seed attains the width of about a centimeter on its broad sides (pl. 5, fig. 62). The coat now measures from 688 to 900 micra thick at the lateral portion of the seed. Interspersed in this spongy ground parenchyma of the outer coat are vertically elongated latex vessels. The hypodermal cells become smaller and more compact towards the epidermal layers.

At maturity of the seed the testa becomes considerably thinner and measures about 128 micra thick; it is dark brown, leathery, and shiny outside. The cells shrink and collapse together, their walls remaining compact and compressed. Some of the latex vessels may often persist as white spots in transverse section.

(*2*) *Inner coat or tegmen.* The inner integument is usually thinner than the outer (pl. 1, fig. 10; pl. 4, fig. 58). As the young seed matures, the tegmen which increases a little in width becomes massive at the nucellar portion; its cells are pressed against the nucellus of the young seed as well as against the outer coat. The cells consequently become flattened (pl. 5, fig. 62) and disorganized until all of them almost lose their identity. A few latex cells are

also found in the tegmen. At this time the inner coat measures from 32 to 64 micra at the lateral portion of the seed.

At maturity of the seed the tegmen practically maintains its former thickness, although its cells are no longer recognizable, and the tegmen remains as a very thin, papery, pale coat surrounded by the testa. This coat easily separates from the cotyledons of the mature seed and usually adheres to the testa. The cell walls are much pressed together so that the identity of the individual cells can not be made out.

SUMMARY

The inflorescence of *Sandoricum koetjape* (Burm. f.) Merr. is of the paniculate type and produces numerous flowers, many of which fall shortly after anthesis. Few or no fruits are developed from a single cluster of flowers, the cause of which can be attributed to the degeneration of the microspores and the female haploid generation. In the male haploid generation degeneration sets in after the formation of the microspores. In the female gametophyte, degeneration may set in any time beginning with the tetrad stage.

The floral primordium arises from the axil of a bract on the ultimate branchlet of the inflorescence and its organs arise as follows: sepals, petals, stamens, carpels, and disc.

The stamen early forms the filament and the anther, the former fusing to form the staminal tube which bears the anthers. Two-celled archesporium is differentiated below the epidermis at each lobe of the anther, and this early cuts off an outer primary parietal layer and an inner sporogenous layer. The primary parietal cells by periclinal divisions form four to five layers of parietal tissue, the outermost layer of which gives rise to the endothecium, and the innermost, the tapetum. The primary sporogenous cells divide but once and form four microspore mother cells. The division of the microspore mother cell is successive and the microspores become separated by furrowing.

The microspore possesses three nuclei long before dehiscence.

The anatropous megasporanges with superior micropyles are ten in number, two in each locule, only five or less normally develop in the mature fruit. Cases where both megasporanges in a locule develop into seeds are not uncommon. The megasporanges are bitegumentary and these integuments arise *basipetally*.

A single-celled archesporium differentiates at the summit of the nucellus below the epidermis and this divides periclinally to

form an outer primary parietal cell and an inner megaspore mother cell. The primary parietal cell, together with the epidermis and hypodermal cells of the nucellus, early form an extensive parietal tissue which buries the megaspore mother cell way deep in the chalaza.

A row of four megaspores is formed, the lowermost of which gives rise to the normal seven-celled megagametophyte. Cases where more than one megaspore does function are described, but these never give rise to normal megagametophytes.

Dehiscence of the microspores takes place before anthesis, and fertilization is normal.

The outer half of the pericarp of the fruit forms the outer yellowish to flesh-colored "skin," while the remaining interior half contributes wholly to the edible, usually sweet, fibrous, translucent portion of the fruit. The latter adheres tenaciously to the stony layers or shells arising from the epidermis of the pericarp surrounding each of the loculi.

The seed possesses two distinct coats, the testa and the tegmen; these coats are easily distinguished from each other at maturity of the fruit. The seed is usually enclosed in a thin stony shell. Sometimes two seeds are developed in each locule or in a single stony shell; upon germination two plants consequently sprout and this phenomenon is responsible for what has frequently been taken as a case of polyembryony in *Sandoricum koetjape* (Burm. f.) Merr.

The endosperm is of the nuclear type, and is totally absorbed by the embryo which consists of a stubby radicle and short plumule, both of which lie between two plano-convex cotyledons. No trace of the nucellus is present in the mature seed.

LITERATURE CITED

CHAMBERLAIN, C. J. 1932. Methods in plant histology. xiv + 416 p., 140 fig. Chicago: The University of Chicago Press.

CHEESMAN, E. E. 1927. Fertilization and embryogeny in *Theobroma cacao*. Ann. Bot. 41: 107–126. *Fig. 1–20.*

COULTER, J. M., AND J. C. CHAMBERLAIN. 1903. Morphology of angiosperms. x + 348 p., 113 fig. New York: D. Appleton and Company.

DALHGREN, K. V. D. 1927. Über das Vorkommen von Starke in den Embryosacken der Angiospermen. Ber. d. Deutsch. bot. Gesells. 45: 374–384.

ENGLER, A., AND E. GILG. 1924. Syllabus der Pflanzenfamilien. xliii + 420 p., 462 fig. Berlin: Verlag von Gebrüder Bornstraeger.

HEGELMAIER, F. 1903. Zur Kenntniss der Polyembryonie von *Euphorbia dulcis* Jacq. (*purpurata* Thuill.) Ber. d. Deutsch. bot. Gesells. **21**: 6–19. *Pl. 2.*

JUEL, H. O. 1915. Untersuchungen über die Aufflösung der Tapetenzellen in den Pollensacken der Angiospermen. Jahrb. f. wiss. Bot. **56**: 337–364. *Pl. 4–5.*

JULIANO, J. B. 1926. Origin, development, and nature of the stony layer of the coconut (*Cocos nucifera* Linneaus). The Philippine Jour. Sci. **30**: 187–200. *Pl. 1–3.*

JULIANO, J. B. 1932. The cause of sterility in *Spondias purpurea* Linn. The Philippine Agriculturist **21**: 15–24. *Pl. 1–5.*

JULIANO, J. B., AND N. L. CUEVAS. 1932. Floral morphology of the mango (*Mangifera indica* Linn.) with special reference to the Pico variety from from the Philippines. The Philippine Agriculturist **21**: 449–467. *Pl. 1–5.*

JULIANO, J. B., AND P. E. ALCALA. 1933. Floral morphology of *Musa errans* (Blanco) Teodoro var. *botoan* Teodoro. The Philippine Agriculturist **22**: 91–126. *Pl. 1–5; fig. 1.*

LYON, F. M. 1898. A contribution to the life history of *Euphorbia corollata.* Bot. Gaz. **25**: 418–426. *Pl. 22–24.*

MAHESWARI, P. 1931. Contribution to the morphology of *Albizzia lebbek.* Jour. Indian Bot. Soc. **10**: 241–264. *Pl. 1–3; fig. 1–3.*

MERRILL, E. D. 1923-1926. An enumeration of Philippine flowering plants. 4 vol. vii + 2136 p., 6 pl., 3 fig. Manila: Bureau of Printing.

MODILEWSKI, J. 1910. Weitere Beiträge zur Embryobildung einiger Euphorbiaceen. Ber. d. Deutsch. bot. Gesells. **28**: 413–418. *Pl. 12.*

OSAWA, I. 1912. Cytological and experimental studies in *Citrus.* Jour. Coll. Agric. Imperial Univ. (Tokyo) **4**: 83–116. *Pl. 8–12; fig. 1.*

OSAWA, I. 1913. On the development of pollen-grains and embryo-sac in *Daphne,* with special reference to sterility in *Daphne odora.* Jour. College Agric. Imperial Univ. (Tokyo) **4**: 238–364. *Pl. 25–27; fig. 1–3.*

QUISUMBING, E., AND J. B. JULIANO. 1927. Development of ovule and embryo sac in *Cocos nucifera.* Bot. Gaz. **84**: 279–293. *Fig. 1–13.*

REED, E. L. 1924. Anatomy, embryology, and ecology of *Arachis hypogaea.* Bot. Gaz. **78**: 289–310. *Pl. 5–6.*

REEVES, R. G. 1930. Development of the ovule and embryo sac of alfalfa. Amer. Jour. Bot. **17**: 239–346. *Pl. 18–19.*

SCHÜRHOFF, P. N. 1924. Zytologie Untersuchungen in der Reihe der Geraniales. Jahrb. f. wiss. Bot. **63**: 707–759. *Fig. 1–13.*

SCHÜRHOFF, P. N. 1926. Der Zytologie der Blütenpflanzen. xi + 792 p., 282 fig. Stuttgart: Verlag von Ferdinand Enke.

SCHNARF, K. 1929. Embryologie der Angiospermen. xxi + 673 p., 69 illus. Berlin: Verlag von Gebrüden Bertraeger.

SUGUIRA, T. 1925. Meiosis in *Tropaeolum majus* L. Bot. Mag. (Tokyo) **39**: 47–54. *Pl. 1.*

SUGUIRA, T. 1925a. On the meiotic division of pollen mother-cells of *Polygonum savatieri* Nakai. Bot. Mag. (Tokyo) **39**: 291–296. *Pl. 5*

EXPLANATION OF PLATES

Parts of the flower, fruit and seed are designated as follows: anther or stamen (*a*), carpels (*c*), cotyledons (*co*), disc (*d*), embryo sac (*es*), funiculus (*f*), hypocotyl (*hp*), cells of pericarp (*hy*), inner coat or tegmen (*ic*), inner epidermis of pericarp surrounding the locule (*ei*), inner integument (*ii*), locule or cell (*l*), latex vessel (*lv*), megasporange or ovule (*m*), microspore (*mi*), micropyle (*my*), nucellus (*n*), outer coat or testa (*oc*), outer epidermis of pericarp (*oe*), outer integument (*oi*), petal (*p*), pericarp (*pe*), plumule (*pl*), pollen tube (*pt*), radicle (*r*), sepal (*s*), seed coat (*sc*), stony layer or shell (*sl*), secondary roots (*sr*), staminal tube (*st*), stigma (*sta*), style (*sty*), and vascular bundle (*vb*).

PLATE I.

Fig. 1. Longitudinal section of a floral primordium showing sepals already differentiated. × 26.5

Fig. 2. An older floral primordium showing sepals and petals. × 26.5.

Fig. 3. Longitudinal section of a young flower showing differentiation of the stamens. × 26.5.

Fig. 4. Longitudinal section of an older flower showing the carpels. × 26 .5.

Fig. 5. A still older flower with all its parts fully differentiated. × 26.5.

Fig. 6. Longitudinal section of the carpels showing enlargement of the apex of the floral axis. × 49.75.

Fig. 7. Portion of the longitudinal section of a flower showing the disc., staminal tube bearing the anthers, and the young megasporanges being pushed into the loculi of the carpels. × 26.5.

Fig. 8. Showing position of the young megasporange after the differentiation of the inner integument. × 117.5.

Fig. 9. Showing position of megasporange at the time the two integuments are formed. × 117.5.

Fig. 10. Longitudinal section of a young seed with nuclear endosperm. × 12.5.

Fig. 11. Semi-diagrammatic sketch of a longitudinal section of a flower, at anthesis showing the relative positions of its parts. × 3.75.

Fig. 12. Showing the stigmatic lobes cut at (A) from figure 11. × 49.5.

Fig. 13. Showing the conductive tissue at the style cut at (B) in figure 11. × 23.75.

Fig. 14. Showing the conductive tissues leading to the loculi of the ovary cut at (C) in figure 11. × 23.75.

Fig. 15. Showing the number of megasporanges and loculi in the ovary, cut at (D) in figure 11. × 23.75.

Fig. 16. Portion of a transverse section of an anther before dehiscence showing the endothecium, epidermis and remains of the parietal tissue within which are the microspores. × 245.

PLATE II

Fig. 17a. Portion of a transverse section of a young anther showing the archesporium; one of the cells has divided periclinally. × 1060.

Fig. 17b. Showing the formation of the microspore mother cells after the first division of the primary sporogenous cells; primary parietal cells still undivided. × 1060.

Fig. 18a. An older anther showing the microspore mother cells, tapetum, and early formation of parietal tissue. × 1060.

Fig. 18b. A still older anther with microspore mother cells in early synapsis; note the parietal tissue. × 890.

Fig. 19. Showing binucleate tapetal cells and a portion of the parietal tissue. × 1060.

Fig. 20. A resting microspore mother cell. × 1060.

Fig. 21. Microspore mother cell in synapsis. × 1060.

Fig. 22. Microspore mother cell in open spireme. × 1060.

Fig. 23. Tetrads in late telophase. × 1060.

Fig. 24. Tetrads in resting condition; still embedded in the gelatinous matrix. × 1060.

Fig. 25a. Microspore some time after separation showing vegetative nucleus and two sperm nuclei. × 1060.

Fig. 25b. An older microspore showing degeneration. × 1060.

Fig. 26a. Microspore showing abundance of food granules and degenerating vegetative nucleus; sperm nuclei could not be located. × 1060.

Fig. 26b. Microspore devoid of food granules and containing degenerating vegetative nucleus. × 1060.

Plate III

Fig. 27. Longitudinal section of the nucellus of a young megasporange showing the archesporial cell (megaspore mother cell) in synapsis. × 445.

Fig. 28. An older megasporange showing elongation of the megaspore mother cell before the formation of the thick parietal tissue. × 445.

Fig. 29. Megaspore mother cell in open spireme; note the formation of an extensive parietal tissue. × 445.

Fig. 30. A dyad. × 530.

Fig. 31. Linear tetrad. × 530.

Fig. 32. Showing early degeneration of one of the micropylar megaspores and apparent enlargement of the chalazal megaspore. × 530.

Fig. 33. Degeneration of two micropylar megaspores and development of the third and fourth megaspores. × 530.

Fig. 34. Showing degeneration of the last two basal megaspores. × 530.

Fig. 35. Enlargement of the functional chalazal megaspores. × 530.

Fig. 36. Binucleate megagametophyte; note the remains of the degenerated megaspores. × 530.

Fig. 37. An older megagametophyte showing polarity. × 530.

Fig. 38. A still older megagametophyte. × 530.

Fig. 39. A mature megagametophyte; (*a*) showing the egg apparatus and polar nuclei, (*b*) showing the antipodal cells. × 530.

Fig. 40. Development of the two lowermost megaspores; upper megaspore nucleus has already divided. × 530.

Fig. 41. Megagametophytes derived from two lowermost megaspores; micropylar nucleus of the upper sac has not yet divided. × 445.

Fig. 42. Much older megagametophytes; upper sac has an egg apparatus and polar nuclei; note the distinct polarity in the lower sac. × 445.

Fig. 43. Showing antipodal cells, polar nuclei and absence of egg apparatus. × 530.

Fig. 44. Showing unfertilized megagamete with degenerating synergids; polar nuclei still persisting and embedded in a mass of starch grains. × 445.

Fig. 45. Showing the egg-apparatus and polar nuclei with pollen tube. × 530.

PLATE IV

Fig. 46. A mature megagametophyte; note formation of starch grains at vicinity of polar nuclei and egg-apparatus, and early degeneration antipodal cells. × 530.

Fig. 47. One-celled zygote. × 530.

Fig. 48. Two-celled zygote. × 530.

Fig. 49. Portion of longitudinal section of the ovary wall near the locule showing its homogeneous interior cells delimited by a distinct epidermal layer. × 270.

Fig. 50. Transverse section of ovary wall showing early divisions of the epidermal cells lining the locule. × 270.

Fig. 51. Transverse section of ovary wall showing early differentiation of derivatives from the inner epidermal cells. × 270.

Fig. 52. Further differentiation of derivatives from the inner epidermal cells of ovary wall. × 270.

Fig. 53. Portion of a transverse section of pericarp showing complete differentiation of the stony layer. × 270.

Fig. 54. Stony layer cut longitudinally; same stage as in fig. 53. × 270.

Fig. 55. Transverse section of mature stony layer. × 270.

Fig. 56. Portion of a transverse section of the ovary wall showing outer epidermis sometimes after anthesis; note the presence of latex vessels in the pericarp and the absence of trichomes. × 270.

Fig 57. Portion of a transverse section of pericarp showing epidermis, trichomes, interior cells, latex vessels, and vascular bundles. × 270.

Fig. 58. Portion of a longitudinal section of a megasporange showing two integuments at anthesis. × 270.

PLATE V

Fig. 59. Showing degeneration of egg apparatus due to lack of fertilization × 445.

Fig. 60. Transverse section of a young fruit showing degeneration of one of the megasporanges in each locule. × 27.5.

Fig. 61. Showing degenerated tetrads. × 530.

Fig. 62. Transverse section of the coats of a young seed. × 245.

Fig. 63. Portion of the interior cells of pericarp showing latex vessels and vascular bundles. × 270.

Fig. 64. Section through the edible portion of the pericarp. × 205.

Fig. 65. Showing early differentiation of the edible portion of the pericarp; note the cells of the stony layer above. × 205.

Fig. 66. Diagram of a transverse section of the "seed" showing the edible portion derived from the pericarp, stony layer or shell, and two seeds with their seed coats within. × 1.

Fig. 67. Showing development of two viable seeds within the stony layer (collected September 25, 1933 under the tree.) × 1.5.

Fig. 68. Showing the same seeds after being allowed to grow further in sand for eight days. × 0.5.

Plate VI

Fig. 69. Portion of a transverse section of the outer portion of the pericarp or "skin" showing latex vessels. × 93.

Fig. 70. Portion of a transverse section of the ovary showing the stony layer and the early differentiation of the hypodermal cells into the edible portion. The structure above is the young seed. × 93.

Fig. 71. Portion of a transverse section of the ovary through a locule showing two young seeds, one of which is degenerating; the young stony layer well differentiated from the cells of the pericarp. × 93.

Fig. 72. Showing the filamentous character of the cells of the sweet, translucent edible portion of the pericarp which adheres to the stony layer; plasmolysis has occurred. × 93.

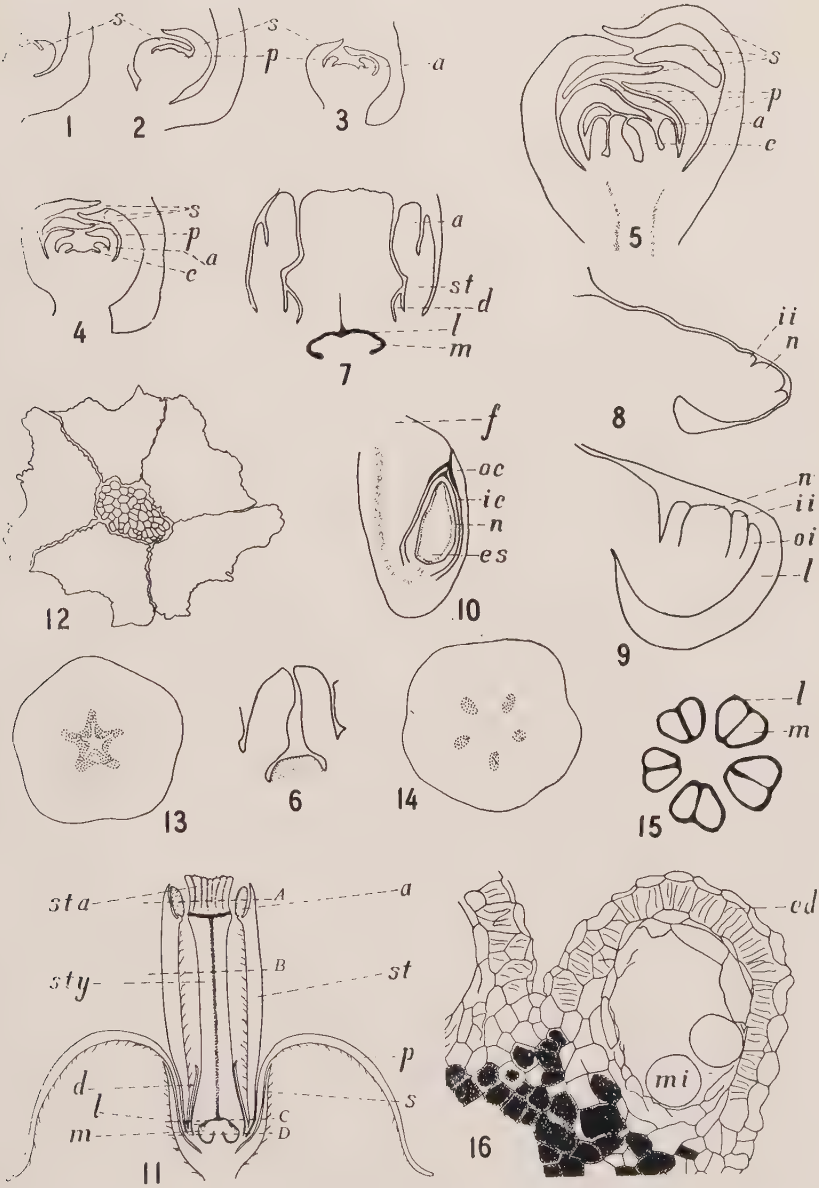

1
2
3
s
p
a
5
c
4
7
st
d
l
m
ii
n
8
f
oc
ic
es
12
10
oi
9
13
6
14
15
sta
A
B
sty
st
C
D
11
ed
mi
16

PLATE I

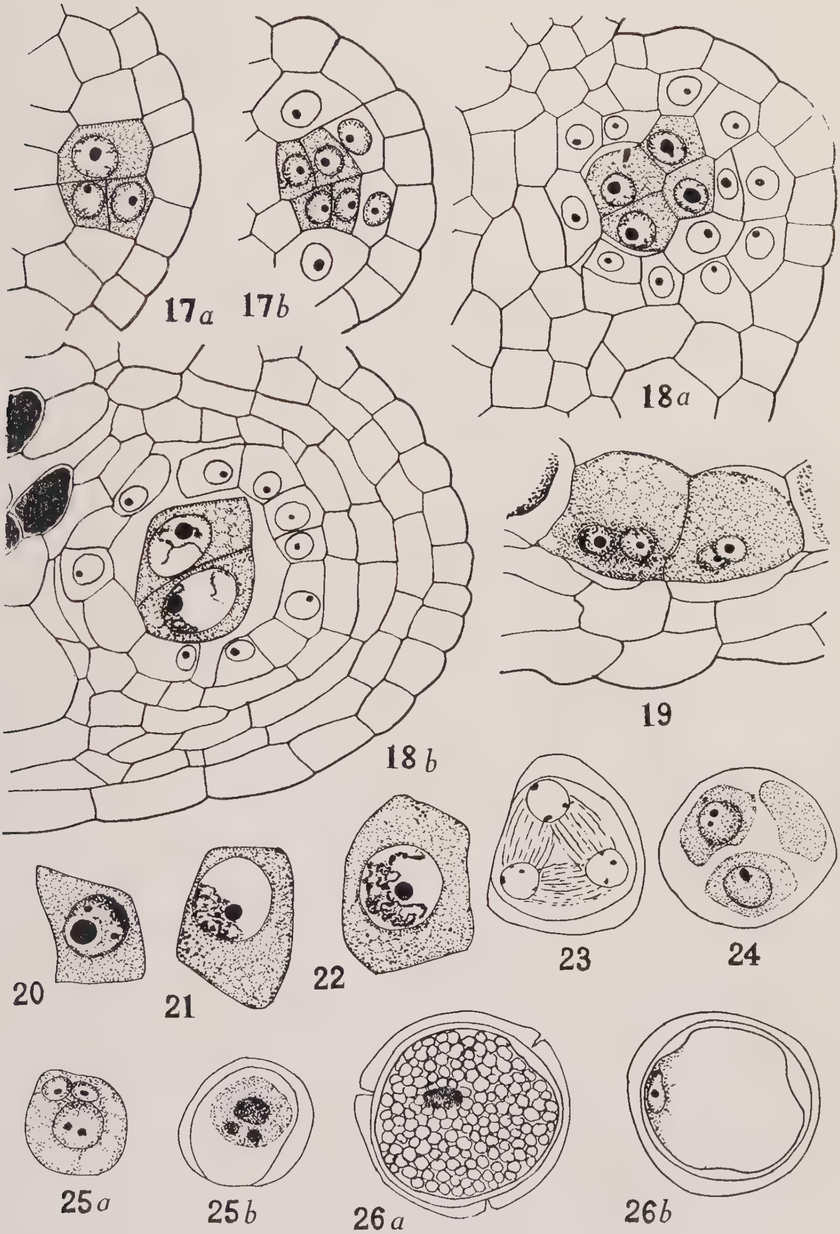


PLATE II

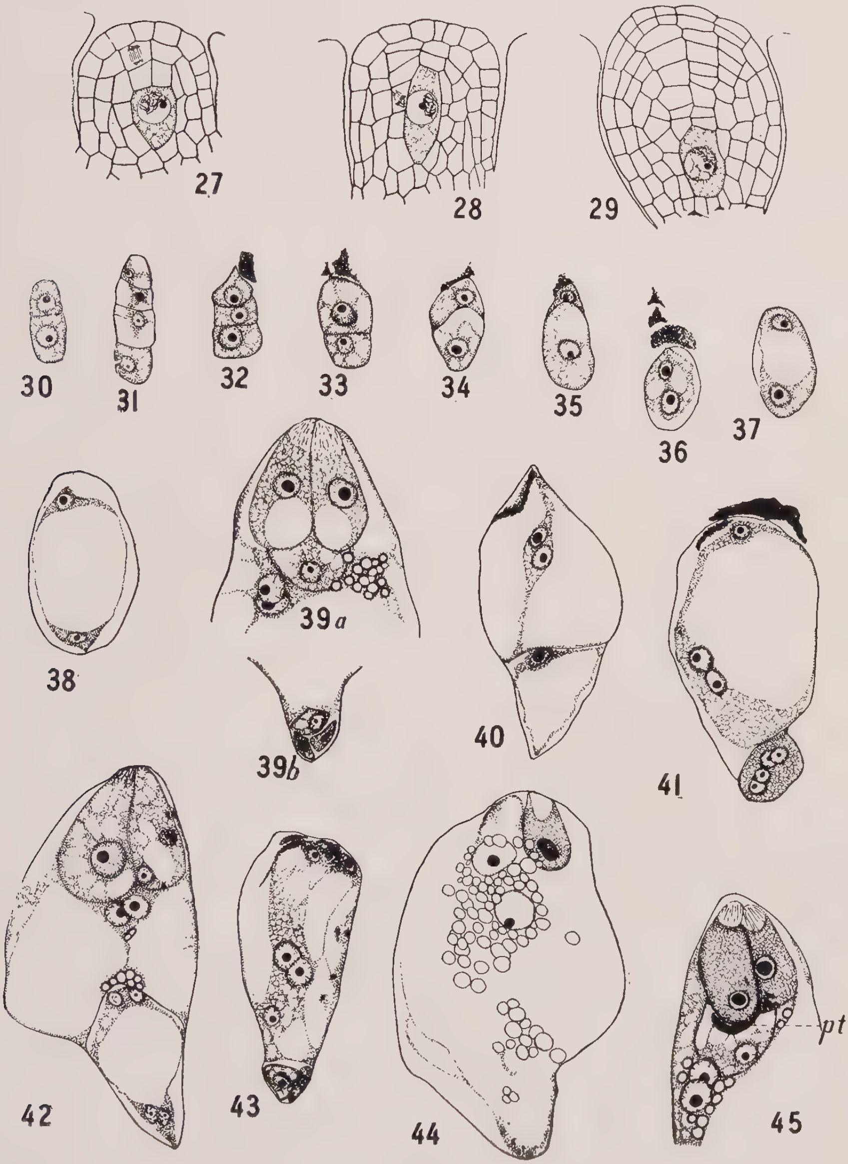


PLATE III

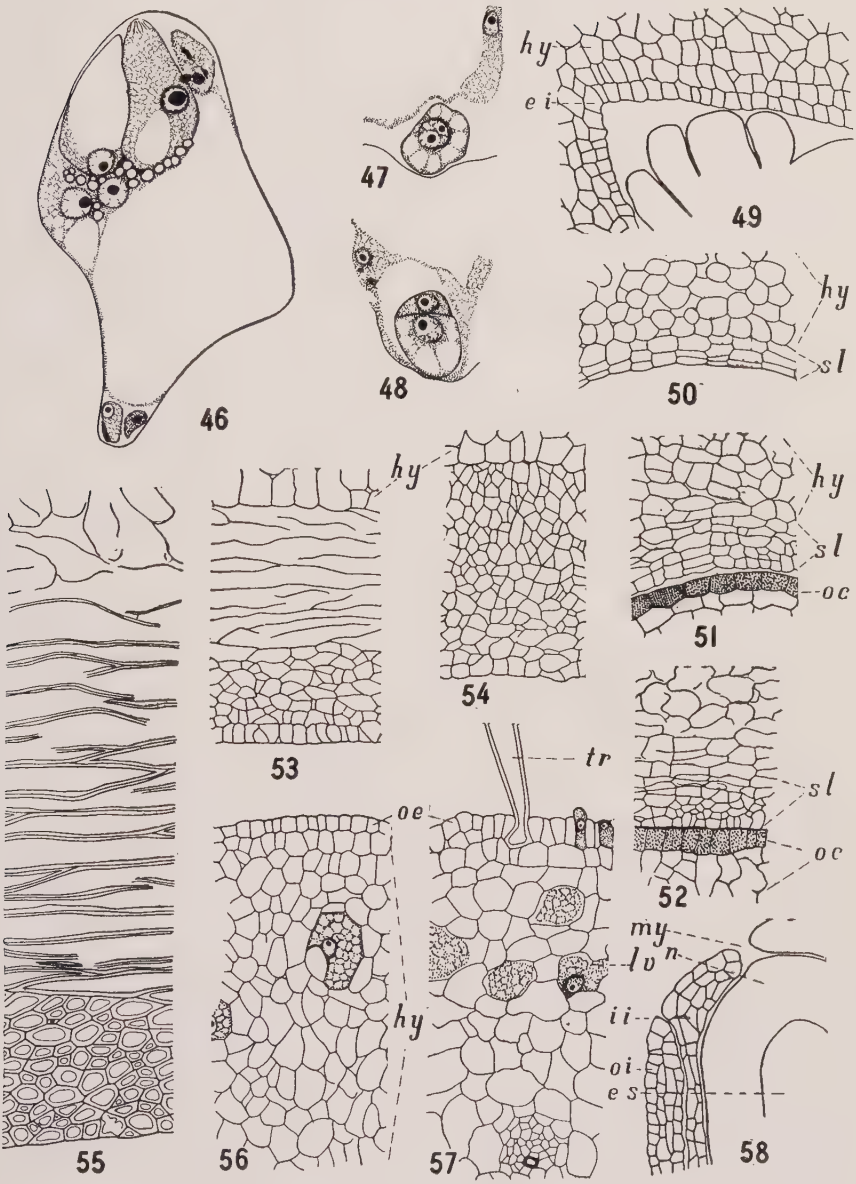


PLATE IV

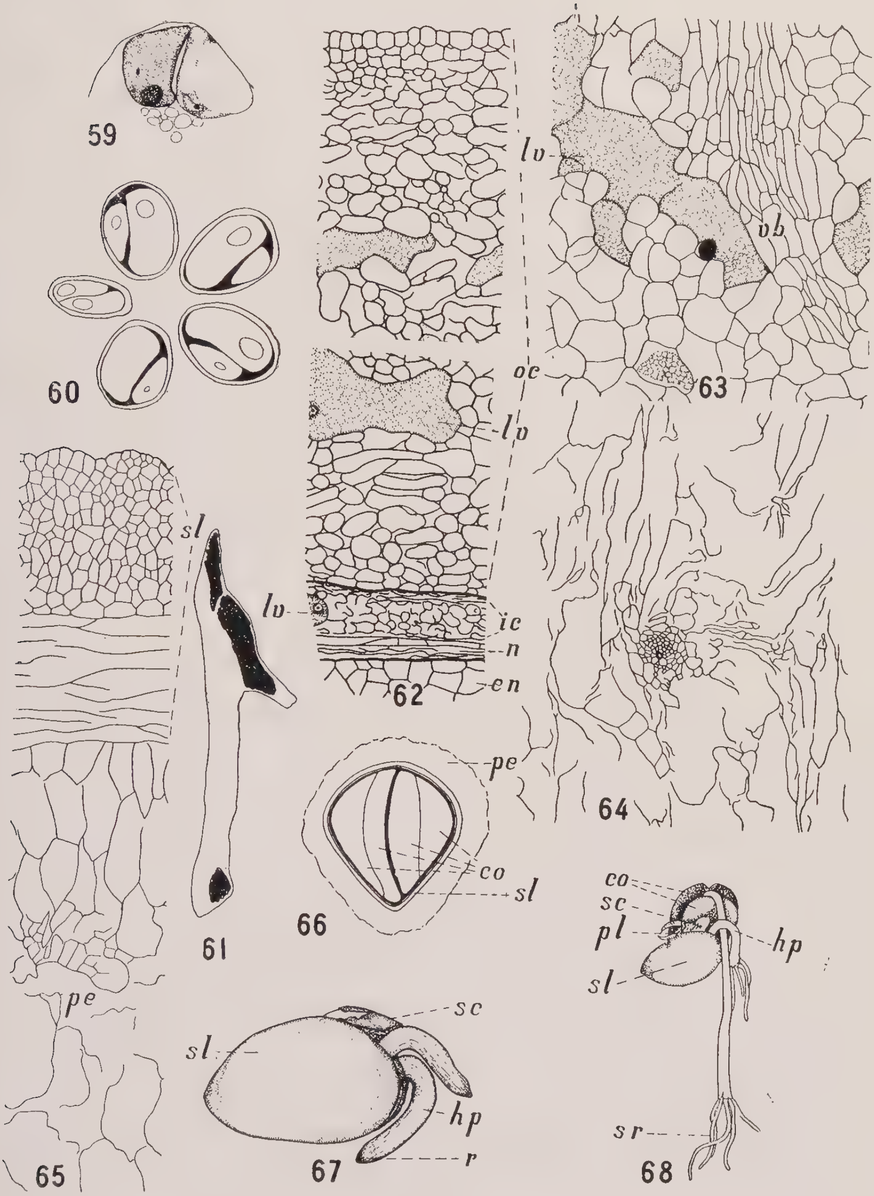


PLATE V

69

70

71

72

PLATE VI

COMPARATIVE STUDIES OF THE VALUE OF CORN AND PALAY AS FEED FOR CHICKENS [1]

GREGORIO S. CHAN AND JUSTIANO D. GUIYAB

For poultry feed both corn and palay are commonly used in the Philippines because in most localities these grains are available throughout the year. As they are such common feeds it was thought to be of importance to determine the value of these two grains for poultry feeding, and to learn which grain would bring the most economical returns to a poultry raiser. Hence, the experiments reported in this paper were undertaken.

REVIEW OF LITERATURE

Jull reported that Katayama (1924) is authority for the statement that rice by-products have a high feeding value. Lippincott (1927) reported that while rice is classed as a fattening feed because of its large proportion of carbohydrates, nevertheless, it is considered an excellent feed for little chicks because of its regulating effect on the bowels. It is usually fed in the grain portion of the ration. Rough rice contains more digestible nutrients than any other grain fed in the United States. But, Mamaril (1925) studying the supplementary actions of some naturally occurring feeds for feeding chicks observed that a heavy mortality, ranging from 50 to 88 per cent, resulted among the chicks in the ration of which palay meal was one of the ingredients used.

Studies conducted at the Arkansas Experiment Station to determine the value of rice by-products as feed for laying hens showed that the average weight of the eggs was the greatest in the pens receiving the greatest amounts of rice and rice by-products (Anonymous, 1927). These pens, however, produced the smallest number of eggs; this possibly might account for the slight increase in average weight. Brooks, Church and Haskell (1905) reported that rice rations gave a very satisfactory egg yield, but rice is too expensive to be fed economically. It was selected for experimental purposes

[1] Theses presented for graduation, 1933, with the degrees of Bachelor of Agriculture and Bachelor of Science in Agriculture from the College of Agriculture Nos. 382 and 383; Experiment Station contribution No. 955. Prepared in the Department of Animal Husbandry under the direction of Dr. F. M. Fronda.

on account of its low fiber content. Studies conducted at the Louisiana Station showed that laying hens receiving rations containing from 10 to 30 per cent of rice products produced as well as hens receiving rations containing no rice products (Anonymous, 1930).

Lamon and Lee (1929) stated that rice hulls are worthless as a poultry feed. Rice bran when not adulterated with hulls and when not containing over 12 per cent fiber is a nutritious feed when used in limited quantities with other feeds. Rice is of special value in adding variety to chick feeds on account of the small size of the grains. These writers contended that rice is about equal in value with corn for live stock but probably not quite so valuable for poultry as it is not liked as well by poultry as corn is. But, in studies conducted by Tuason and Fronda (1924) it was observed that rough rice (palay) was the most palatable of the grains studied, corn being second.

According to Henry and Morrison (1929) corn is a great energizing, heat giving, and fat furnishing feed, and successful animal husbandry rests upon this imperial crop. Because of the abundance of starch and oil it contains, corn is classified as a fattening feed. Mussehl, Calvin, Halbersleben and Sandsuedt (1921) reported that yellow corn is deficient in several of the essential qualities necessary for the complete nutrition of growing chicks. However, when a ration of corn alone was supplemented with 5 per cent of a complete ash mixture and 15 per cent casein there was a decidedly marked improvement in the ration.

In Australia, it is the opinion of many people who keep poultry that maize can be fed with safety only in the winter months, and that it is dangerous, or at least harmful, to use it in summer. But the report of studies on maize feeding by the Department of Agriculture, Victoria (1922) indicated, although there was no definite conclusion, that maize fed in conjunction with other foods can be used with safety in all seasons of the year.

OBJECTS OF THE PRESENT STUDY

The objects of these experiments were: (*a*) To determine the influence of corn and palay given separately and the combination of corn and palay on the rate of growth and egg production of chickens; and (*b*) to determine which of these feeds is the most economical feed for chickens.

PART I

VALUE OF CORN AND PALAY AS FEED FOR YOUNG CHICKS

Plan of the experiment. The chicks used in these experiments were hatched from Los Baños Cantonese eggs furnished by the College. There were three sets studied. All the chicks used in the experiments were artificially hatched. The first hatch of 72 chicks which was divided into three lots of 24 chicks each was taken off on June 1, 1932. The second hatch of 138 chicks was taken off on June 25, 1932. This hatch was divided into three lots of 46 chicks each. The third hatch of 360 chicks was taken off on July 24, 1932. This hatch was divided into three lots of 120 chicks each. The chicks in all three hatches were taken down from the incubator 24 hours after they were hatched. Before taking them down, the chicks were properly legbanded and weighed.

Feeding, care and management. The chicks were brooded in a fireless brooder. They were hand fed. The grain mixture used for each lot consisted of the following, all parts by weight: Corn lot (lot 1), corn alone; palay lot (lot 2), palay alone; and check lot (lot 3), corn and palay, 1:1.

The mash mixture consisted of the following:

LOT	INGREDIENTS [a]		
	Corn meal	Palay meal	Shrimp meal
Corn, yellow	8	—	2
Palay	—	8	2
Check	4	4	2

[a] Mixed as parts by weight.

The feeds of all the lots were given in an open mash trough to which the chicks had free access. Drinking water, changed four times a day, was accessible to the chicks at all times. Chopped green grass was given to the chicks every day.

Records. The chicks were weighed weekly from the first day of the experiment till the end of the twelfth week and their individual weights were recorded. The feed consumption of each lot was carefully determined. The mortality of each lot was also recorded.

Growth of chicks. The weight of the chicks at different ages was used as the criterion in determining the influence of the feeds on the growth. The average weekly weights of the chicks during the brooding period are given in table 1.

By reference to table 1, it may be seen that during the first two weeks, all the lots had practically the same rate of growth. During the third week the rate of growth of chicks in lot 1 (corn fed lot) was faster than that of the chicks in lot 2 (palay fed lot). As the chicks grew older, the difference in the rate of growth in lot 1 (corn fed lot) and lot 2 (palay fed lot) became more marked. Lot 3 (corn and palay fed lot) had always the tendency to be intermediate between lots 1 and 2, although it had a greater tendency to approach the weight of the chicks fed with corn (lot 1) than those fed with palay (lot 2).

In all of the three trials this relationship among the different lots persisted. Possibly, the fact that the digestible coefficient of the nutrients of corn is higher than the digestible coefficient of the nutrients of palay (Holst and Newlon, 1931) may have been the cause. That corn has a nutritive ratio [2] of 1:9.9 and palay, 1:14.5, and that corn is more digestible than palay (Holst and Newlon, 1931) are probably two of the reasons why the corn fed chicks (lot 1) should gain more in weight than the palay fed chicks (lot 2). It is also probable that the protein combination of corn and shrimp meal is more efficient than that of palay and shrimp meal. Further study, however, is necessary to verify this statement.

The weights of the chicks during the twelfth week were subjected to statistical study. When lot 1 (corn fed lot) was compared with lot 2 (palay fed lot) it was found that the difference was 41.0 ± 8.851, which is very significant, showing the superiority of corn over palay. When lot 1 (corn fed lot) and lot 3 (corn and palay fed lot) were compared it was found that the difference was only 10.6 ± 7.427 showing that corn had no special advantage over the mixed corn and palay when fed to chicks. But when lot 2 (palay fed lot) and lot 3 (corn and palay fed lot) were compared, the difference was found to be 30.4 ± 9.429 which is also significant. These figures show that under the conditions of this study the mixture of corn and palay has an advantage over palay alone when fed to chicks. But in an experiment comparing the effects of mixed and single ration on chicks, Cruz (1918) found that the palay-fed chicks were heavier than those fed with corn.

Mortality of chicks. Table 2 shows the comparison of mortality of the chicks computed on the basis of periods four weeks long. From this table it may be seen that lot 2 (palay fed lot had the highest percentage of mortality; lot 3 (corn and palay fed lot), the second;

---

[2] Taken from the table of average digestible nutrients of feeding stuffs found in the Philippines compiled by the Department of Animal Husbandry.

and lot 1 (corn fed lot), the lowest. The same relationship was noted in all of the three trials. This may be due to the presence of rice hulls in the rations of lots 2 and 3. It is claimed by Henry and Morrison (1929) that rice hulls are irritating and injurious to the walls of the stomach and intestines so that it is not advisable to feed them to live stock. This effect of the hulls, at least in part, was probably one of the causes of the heavy mortality in lot 2 (palay fed lot) and lot 3 (corn and palay fed lot). As a result of this condition the chicks in lot 2 (palay fed lot) were not so vigorous as the chicks in the other two lots, hence, they were very susceptible to roup, a disease prevailing at the time the experiment was begun.

Amount and cost of feed consumed. Table 3 shows the relative amount and cost of feed consumed at different stages. By reference to this table, it may be seen that there was no marked difference in the amount of feeds consumed by the three lots.

The total amount of feed consumed per 100 weanlings in this experiment is a little lower than the figure reported by Paje (1927) and Amon (1930). The total amount of feed consumed per chick in the whole brooding period, twelve weeks, was 1.5 kgm. in lot 1 (corn fed lot); 1.7 kgm. in lot 2 (palay fed lot); and 1.7 kgm. in lot 3 (corn and palay fed lot).

With calculations based on the market prices of the feeds, one kilogram of the grain ration of lot 1 (corn fed lot) cost ₱0.042 and of the mash, ₱0.0578. In lot 2 (palay fed lot) one kilogram of the grain ration cost ₱0.047 and of the mash, ₱0.0618. In lot 3 (corn and palay fed lot) one kilogram of the grain ration cost ₱0.0445 and of the mash, ₱0.0598. With these different costs of feeds as the basis of computation, it was found that the cost of feed needed to produce a weanling chick in lot 1 (corn fed lot) was ₱0.089; in lot 2 (palay fed lot), ₱0.1012; and in lot 3 (corn and palay fed lot), ₱0.0996.

Summary. 1. The corn fed chicks grew faster than those fed with palay. The corn-palay fed chicks were intermediate between the other two.

2. The palay fed chicks had the highest percentage of mortality; those fed with the corn-palay combination had the second highest and the corn fed chicks had the lowest.

3. There was no marked difference in the amounts of feed consumed by the three lots.

4. The corn fed chicks were more uniform in size than the palay fed chicks. The corn-palay fed chicks were a little better than those fed with palay, but not so uniform as those that were given corn.

PART II

VALUE OF CORN AND PALAY AS FEED FOR REARING PULLETS

Plan of the experiment. The weanling pullets (twelve weeks old) in all lots of the second and third sets of Part I were used in these experiments. At the beginning of this observation, in the second set there were eight pullets in each lot and in the third, thirty-one pullets in each lot.

The pullets were housed on the range in portable rearing houses, separated by wire fences. The same arrangement of lots as in Part I was followed; that is, pullets from lot 1 in Part I were placed in lot 1 and received the same ration as in lot 1 of Part I; pullets from lot 2 in Part I were placed in lot 2 and received the same ration; and the pullets from lot 3 in Part I were placed in lot 3 and received the same ration. During the twenty-second week, when the pullets were about to lay eggs, they were transferred to different laying houses. The pullets were then trapnested.

Feeding, care and management. The pullets in all the lots in both sets were hand fed. Drinking water, changed four times a day, was accessible to the pullets at all times. The conditions of all the lots were made as identical as possible, differing only in the kind of feed given.

Records. The weekly weights of the pullets from the twelfth to the twenty-fourth week were recorded. The amount of feeds consumed by each lot was determined. A mortality record of each lot was kept. The date of laying of the first egg by the pullets and the number of eggs laid in each lot were recorded.

Weight of pullets. Table 4 shows the rate of growth of the pullets raised to twenty-four weeks old. A study of this table reveals the fact that the pullets in lot 1 (corn fed lot) grew consistently faster than those in lot 2 (palay fed lot).

It may be further observed in this table that from the thirteenth to the eighteenth week the difference in the rate of growth of the pullets in lot 1 (corn fed lot) and lot 2 (palay fed lot) became less and less marked. But beginning with the nineteenth week, the difference in the rate of growth became more marked. While the palay fed pullets (lot 2) had increased in their rate of growth, the corn and palay fed pullets (lot 3) had also increased. Beginning with the fifteenth week the pullets in lot 3 (corn and palay fed lot) became slightly heavier than those in lot 1 (corn fed lot) and remained so up to the nineteenth week. During the nineteenth week the rate of growth of lot 1 (corn fed lot) and lot 3 (corn and

palay fed lot) became practically the same. But during the twenty-fourth week the corn fed pullets (lot 1) decreased in weight. This was probably due to the fact that a number of the pullets were laying at that time. The behavior of the pullets in lot 2 (palay fed lot) and in lot 3 (corn and palay fed lot) during the first few weeks on the range may be due to the influence of the green succulent feeds. Mussehl and Calvin (1921) stated that green feeds improve the physical condition of the ration, serve as accessory contribution and stimulate appetite.

The weights of the pullets during the twenty-fourth week, were subjected to statistical study. When lot 1 (corn fed lot) was compared with lot 2 (palay fed lot) the difference was found to be 65.8 $\pm$ 36.2 which was insignificant. The probable reason that there was no significant difference in the average weight of the pullets in lot 1 (corn fed lot) and those of lot 2 (palay fed lot) was that during the twenty-fourth week the pullets in lot 1 (corn fed lot) were already laying eggs. When lot 1 (corn fed lot) and lot 3 (corn and palay fed lot) were compared, the difference was found to be 3.8 $\pm$ 36.47, which was insignificant. When lot 3 (corn and palay fed lot) and lot 2 (palay fed lot) were compared the difference was found to be 52.0 $\pm$ 41.35 which was also insignificant.

Mortality of pullets. Table 5 shows the total percentage of mortality of the pullets for the whole rearing period. It may be seen from this table that, as in Part I, lot 2 (palay fed lot) again had the highest percentage of mortality of all the three lots. Report of the post mortem examinations of the birds that died in lots 2 and 3 revealed that death may not have been due to any pathogenic disease. The blood of the birds that died was examined microscopically and it was found that it did not contain any pathogenic microorganism. However, on macroscopical examination of the digestive tract it was found that there was "internal hemorrhage of the duodenum."

Amount and cost of feeds consumed. Table 6 shows the average amount and cost of feed consumed by the pullets during the rearing period. By reference to this table, it may be seen that there was no marked difference in the amount of feed consumed by the birds in the three lots. The individual amount of feed consumed in each lot for the whole rearing period was 5.0 kgm. in lot 1 (corn fed lot); 4.9 kgm. in lot 2 (palay fed lot); and 4.7 kgm. in lot 3 (corn and palay fed lot). The amount of feeds consumed per 100 birds in all the lots in this experiment is higher than Paje's (1927) findings but a little lower than the findings of Amon (1930). The

amount of feed consumed per 100 birds from the twelfth to the twenty-fourth week, as found by Paje (1927), was 391.5 kgm.; by Amon (1930), 539.3 kgm.

Basing computation on the market prices of the feeds, the cost of the grain consumed per 100 pullets in lot 1 (corn fed lot) was ₱10.44 and of the mash, ₱14.47, or a total of ₱24.91. The cost of grain consumed per 100 birds in lot 2 (palay fed lot) was ₱11.56 and of the mash, ₱15.16 or a total of ₱26.72. In lot 3 (corn and palay fed lot) the cost of grain consumed per 100 birds was ₱10.52 and of the mash, ₱14.21 or a total of ₱24.73. The individual cost of feed consumed in each lot for the whole rearing period was ₱0.25 in lot 1 (corn fed lot); ₱0.27 in lot 2 (palay fed lot); and ₱0.25 in lot 3 (corn and palay fed lot). The difference in the cost of feed consumed was mainly because palay cost more per kilogram than corn at the time of the experiment.

Value of gain less the cost of feed. Table 7 shows the data on the gain and the cost of the feeds consumed. Subtracting the initial weight of the birds at the end of the twelfth week from their final weight at the end of the twenty-fourth week, it was found that the difference between lot 1 (corn fed lot) and lot 3 (corn and palay fed lot) was not marked. This may be due to the fact that during the twenty-fourth week several birds in lot 1 (corn fed lot) were laying so that their average weight decreased. The total gain made by the pullets in lot 1 (corn fed lot), was 68.2 kgm.; in lot 2 (palay fed lot), 63.5 kgm.; and in lot 3 (corn and palay fed lot), 69.5 kgm. If the gain in weight was valued at ₱0.60 per kilogram the gain was worth ₱40.92 in lot 1 (corn fed lot); ₱38.10 in lot 2 (palay fed lot); and ₱41.70 in lot 3 (corn and palay fed lot). Subtracting the cost of feed consumed from the cost of the total gain there was a balance of ₱16.01 in lot 1 (corn fed lot); ₱11.38 in lot 2 (palay fed lot); and ₱16.97 in lot 3 (corn and palay fed lot) showing that corn as feed for growing pullets was more profitable than palay alone, but the same when combined with palay.

Maturity of pullets. Pullets are considered to be mature when they have laid their first egg. By reference to table 8 it may be observed that there was no appreciable difference in the ages of the pullets when they laid their first egg. However, when the percentage of pullets laying at the end of the twenty-fourth week was taken into consideration it was found that the largest number of birds were laying in lot 1 (corn fed lot); lot 3 (corn and palay fed lot) was second; and lot 2 (palay fed lot) had the fewest. The

number of pullets laying at the end of the twenty-fourth week in lot 1 (corn fed lot) was 10 or 26.31 per cent; in lot 2 (palay fed lot), 3 or only 12.50 per cent; and in lot 3 (corn and palay fed lot), 6 or 18.18 per cent. According to Lippincott (1927) constitutional vigor is the conductor that makes reproduction possible. On this principle, since the pullets in lot 1 (corn fed lot) were more vigorous than those in the other two lots, more birds in this lot (corn fed lot) should lay than in either of the other two.

The number of eggs collected at the end of the twenty-fourth week was 27 in lot 1 (corn fed lot); 14 eggs in lot 2 (palay fed lot); and 20 eggs in lot 3 (corn and palay fed lot). More eggs were collected from lot 1 (corn fed lot) than from the other two lots because there were more birds in that lot laying at that time. If the eggs collected from each lot were sold at ₱0.03 each, the amount received for the eggs collected from lot 1 (corn fed lot) would be ₱0.81; from lot 2 (palay fed lot), ₱0.42; and from lot 3 (corn and palay fed lot), ₱0.60.

Summary. 1. As a whole, the corn fed pullets gained more weight than the palay fed pullets. The corn-palay fed pullets tended to be intermediate between the two.

2. The palay fed pullets had the highest percentage of mortality, the corn-palay fed pullets had the second highest and the corn fed pullets had the lowest.

3. There was no appreciable difference in the amount and cost of the feeds consumed by the pullets in the three lots.

4. The value of the gain less the cost of feed consumed per 100 pullets was ₱16.01 with the corn fed pullets, ₱11.38 with the palay fed pullets and ₱16.47 with the corn-palay fed pullets.

5. There was no appreciable difference among the three lots in the age of the birds when the first egg was laid.

6. At the age of twenty-four weeks, more pullets were laying in the corn fed lot than in either of the other lots. The corn-palay fed lot was second and in the palay fed pullets there were the fewest.

PART III

VALUE OF CORN AND PALAY AS FEED FOR LAYING HENS

The flock. In this study, eighty-one Los Baños Cantonese pullets were used. These were divided into three lots of twenty-seven birds each. Two cockerels were placed in each lot. The pullets were about the same age. They were housed in pens of the same size, with grassy yards adjoining each pen.

Feeding. The feed consisted of grain and mash, fifty-fifty by weight as far as possible. The grain mixture consisted of the following:

Corn lot (lot 1) .... corn, yellow
Palay lot (lot 2) .... palay
Check lot (lot 3) .... corn and palay, 1:1

The mash mixture consisted of the following:

LOT	INGREDIENTS [a]				
	Rice bran	Copra meal	Corn meal	Palay meal	Shrimp meal
Corn	—	3	5	—	2
Palay	—	3	—	5	2
Check	4	3	1	—	2

[a] Given as parts by weight.

It should be noted that the test rations used in this study were compared with the standard laying ration of the College. The grain ration was given every morning and afternoon. The mash was given *ad libitum.* Wet mash was given about ten o'clock in the morning. Care was taken that the consumption of grain and mash was about the same. Fresh water was provided at all times during the experiment.

Records kept. The birds were trapnested and the total egg production for each month and for the year was carefully recorded. The amount of feed consumed each month and for the year in each lot was recorded; and the cost of egg production was determined. The initial weight of each bird was taken at the beginning of the experiment, and monthly thereafter. Mortality records were also kept.

Egg production. The percentages of egg production of the different lots are given in table 9. From this table it may be noted that there was no significant difference in the average percentage of egg production in the three lots. However, the highest monthly egg production of lot 1 (corn fed lot) was in January, with 46.28 per cent. In February, in lot 2 (palay fed lot) the percentage of egg production was 46.23, and in lot 3 (check lot), 46.29 per cent.

It is interesting to note that the seasonal distribution of egg production in this experiment conformed with that reported by Fronda (1928), the highest percentage being in February. It will be noted, also, that the corn fed birds produced more eggs than the

palay fed only during the first half of the experiment, but they were not able to keep up this production. On the other had, the palay lot maintained its egg production throughout the experiment. The decrease in the corn lot may have been due to the fact that the birds in this lot became so fat that the production of eggs was interrupted. It has been reported that if hens are too fat, the proper functioning of the oviduct is interfered with. Misshaped eggs are accounted for by an abnormal condition of the lower part of the oviduct which prevents the necessary expansion, and as the shell is soft, it is compressed into peculiar shapes, (Anonymous, 1930). In the present study, the corn fed lot laid more soft-shelled eggs than either of the other two lots. This lot produced eight midgets also; the palay fed lot produced only one midget and the check lot, two.

Egg production per hen and weight of eggs. Table 10 shows the actual number of eggs produced by the three lots and the weights of the eggs in each lot. By reference to this table it may be seen that the eggs from the corn fed lot were the heaviest, and from the check lot, the lightest. When the probable errors of the means were determined, the following results were obtained: The corn lot gave 41.6700 ± 0.1413; the palay lot, 41.3106 ± 0.1502; the check lot, 40.4220 ± 0.1864. The probable errors of the differences were: when the corn and palay lots were compared, 0.3594 ± 0.2062; when the corn and the check lots were compared, 1. 2480 ± 0.2339; when the palay fed lot and the check lot were compared, 0.8886 ± 0.2394. These figures show that there was no significant difference in the weight of eggs in the corn fed and palay fed lots. There was a significant difference in the weight of the eggs in the corn fed and the check lots. There was also a significant difference in the weight of eggs in the palay fed and check lots. The eggs from the corn fed and palay fed lots were heavier than those of the check lot. These results corroborate those reported at the Arkansas Experiment Station (Anonymous, 1927) where it was observed that the pen receiving the greatest amount of rice and rice by-products produced the heaviest eggs, but the smallest number.

Feed consumption. The amounts of feed consumed by the birds in the three lots are given in table 10. From this table it may be seen that lot 2 (palay fed lot) and lot 3 (check lot) consumed more feeds than lot 1 (corn fed lot). This difference may be explained on the ground that during the middle and latter parts of the experiment there were many broody hens in lot 1. These birds were fat and heavy and ate less heartily than is usual. Comparing the corn fed and palay fed lots, it may be seen that the palay lot, lot 2,

consumed the most grain. This may mean that rough rice was more palatable than corn. Tuason and Fronda (1924) reported that among the grains, rough rice was the most palatable and corn ranked second. Taking the three lots, it may be seen that lot 3 consumed the most grain. Therefore, it would seem that a mixture of corn and palay of equal parts was the most palatable of the grain rations used in this experiment. In mash, lot 2 consumed the most and lot 1, the least. Taking the average feed consumption per bird in the year, it may be seen from the same table that lots 2 and 3 consumed significantly more feed than lot 1. It was observed in the palay lot that the rice hulls were not picked up by the birds. Knapp (1900) reported that rice hulls possess a low degree of feeding value, and are deficient in flavor and digestibility.

Relative cost of feed used and of eggs produced. In computing the average cost of one kilogram of each kind of feed, the Department of Animal Husbandry prices at the time that this experiment was conducted were used. They were:

Feed	*Av. cost per kgm. of feeds*
Rice bran	₱0.046
Corn	0.051
Palay	0.047
Shrimp meal	0.250
Copra meal	0.034

By reference to table 11 it may be seen that lot 1 (corn fed lot) consumed ₱44.89 worth of feeds and produced eggs valued at ₱138.60, giving an income of ₱93.71 above the cost of feeds. Lot 2 (palay fed lot) consumed ₱48.85 worth of feeds and produced eggs valued at ₱143.52, giving an income of ₱94.67 above the cost of feeds. Lot 3 (check lot) consumed ₱49.54 worth of feeds and produced eggs valued at ₱142.88, thus giving a profit of ₱93.34 over the cost of feeds.

Cost of production. From table 11, it may be seen that the cost of feeds required to produce one dozen eggs was almost the same in lots 1 and 2, with a difference of only ₱0.013 in favor of lot 1. This slight difference was due to the price of feeds consumed and the total number of eggs produced during the year. Although the value of feeds consumed in lot 1 was slightly less than that in lot 2, the value of the eggs was less, also. Comparing lot 3 with lot 2, there was a difference of only ₱0.005 in favor of lot 2. So, on the whole, there was no appreciable difference among the three lots in the cost of feeds required to produce one dozen eggs. It required ₱0.26 worth of feeds to produce one dozen eggs in the corn lot; ₱0.27, in the palay lot; and ₱0.28, in the check lot.

The total cost of producing one dozen eggs in the corn lot, as shown in table 11, was ₱0.43; in the palay lot, ₱0.45; and in the check lot, ₱0.46. Fronda (1932) found that the total cost of producing one dozen eggs from each of the seven mash mixtures that he studied was ₱0.308, ₱0.39, ₱0.434, ₱0.352, ₱0.366, ₱0.395, and ₱0.434, respectively. Comparing these costs with those of the three lots under the present study, it was found that there was no great difference between the results obtained in this study and the third and seventh lots in Fronda's study in which the ration consisted of 1 part shrimp meal, 5 parts corn meal, no copra meal, and 4 parts rice bran; and 2 parts shrimp meal, 8 parts corn meal, no copra meal and no rice bran—all parts by weight. The slight difference may be because the price of the mash used in the present study was slightly higher than that used by Fronda (1932). Consequently, the total cost of producing one dozen eggs as found in this work would be higher.

Net income from different lots. From the same table, it may be seen that the corn lot gave the highest net income, ₱63.78; the palay lot next, ₱62.10; and the check lot, the lowest, ₱60.31. The corn lot gave a higher net income than the palay lot because the total value of feeds consumed by the birds in this lot was ₱44.89, while it was ₱48.85 in the palay lot. But the difference was not very significant. The check lot ranked the lowest because it was the highest of all the lots in total value of feeds consumed.

Effect of feeds on the weight of birds. The weights of the hens at the beginning and at the close of the experiment are given in table 12. It may be seen from the table that of the three lots studied lot 1 made the most gain in weight; lot 3, second; lot 2, third. Subtracting the average weight of hens at the beginning of the experiment from their average weight at the close of the experiment, the results were 251.00 grams for lot 1, 170.44 grams for lot 2, and 199.82 grams for lot 3. To express the average increase in weight in percentage, the corn lot increased 19.30 per cent; the palay lot, 13.30 per cent; and the check lot, 15.86 per cent. This shows that corn had a decided tendency to make the birds fat. The chemical analysis of corn and the low production of eggs in the corn lot would show that the birds would tend to increase in weight.

Mortality of hens. The percentage of mortality of hens is given in table 13. Throughout the whole experiment only four birds died, one from the corn lot on September 29, 1931, one from the palay lot on May 2, 1932, and two from the check lot, one on September 23, 1931 and the other on April 17, 1932. Expressed in percentage,

the mortality was 3.70 per cent in the corn fed lot, 3.70 in the palay fed lot, and 7.41 in the check lot, all being within the normal range of mortality of 12 per cent a year. There was no difference in mortality of hens in the three lots. This may be due to three factors; namely, good breed, correct feeding, and proper management. Although lot 3 had the greatest mortality of all the lots, it could not be concluded that the birds in this lot were weak or poorly managed because one bird died of "egg bound," not a serious disease. One bird from the corn lot and one from the check died of roup during the first month of the experiment.

Fertility and hatchability of eggs. There were three incubation tests conducted and the combined results of these three tests are summarized in table 13. By reference to this table it may be seen that there was no great difference in the infertility of eggs in the three lots. As to the percentage of D_1 (germs that died during the first week of incubation), the corn lot was 2.66 per cent higher than the palay lot; the check lot was the highest. As to the percentage of D_2 and D_3 (germs that died during the second and third weeks of incubation), the palay lot was the highest; the corn lot, the lowest. The percentage of pipped eggs was the lowest in the corn lot; the palay lot had the highest. These results tend to show that the developing chicks in the corn lot were probably more vigorous than those of the palay lot.

Basing the percentage of hatchability upon all the eggs set, the corn lot topped the list, with the palay lot, second. On the whole, the percentages of hatches in all the three lots were rather low. These might have been higher if the eggs had been hatched during the months that are recommended for hatching. Resananda (1924) observed that the best hatches were obtained in October, November, December, January and February. The percentage of hatch obtained in these tests might have been higher had the incubation work not been done during the hot months. The corn lot ranked first; the palay lot, second; and the check lot, third.

Minor observations. It was observed that the chicks were more uniform in size and vigor in the corn fed lot than in the lot fed with palay. A number of the chicks in the palay fed lot were stunted in growth. The shanks of the chickens in the corn fed lot were very yellow, while those in the palay fed lot had practically no pigment. The yellow color may be due to the fact that yellow corn was used in this experiment (Waite, 1929). The feces of the corn fed chickens were black and sticky; of the palay fed chickens they were gray, moist and oftentimes reddish. It was observed also that there were

more broody hens in the corn fed lot than in the palay fed or the check lots. The time required to break the broodiness of hens was much longer in the corn fed lot than in the other two lots. There were more birds that molted earlier in the corn fed lot than in the other two lots. But the corn fed birds were laying. The chicks hatched from the corn lot were the most vigorous and active of the three lots.

Summary. 1. There was no appreciable difference in the average percentage of egg production between the corn and palay fed pullets.

2. The cost of feeds to produce one dozen eggs in the corn fed lot was ₱0.26; in the palay fed, ₱0.27; in the check lot, ₱0.28.

3. The average yearly production per bird in the corn lot was 132.6 eggs, in the palay lot, 134.4, and in the check lot, 139.0.

4. The pullets in the corn lot gained the most in weight, those in the check lot, second and those in the palay lot, the least.

5. There was no great difference in the fertility of the eggs in the three lots, but the best hatch was from the eggs produced by the corn lot; the palay and the check lots had about the same percentage of hatch.

CONCLUSIONS

From the results obtained in the present study the following conclusions may be drawn:

1. For growing stock, young chicks and rearing pullets, corn is a better feed than palay.

2. For layers, either corn or palay in combination with other feeds will be satisfactory.

3. From the viewpoint of economy in egg production, a poultry raiser should feed corn if the available supply of this grain is as cheap as palay, kilogram for kilogram. A poultryman who lives in a rice region should feed palay.

4. If both corn and palay are abundant, the combination of the two grains will be better than to feed either one alone.

REFERENCES

ANONYMOUS. 1910. Rice and its by-products as feeding stuffs. The Philippine Agric. Rev. 3: 664–667.

ANONYMOUS. 1922. Feeding experiments. Victoria (Australia) Dept. of Agric. Bull. 54: 36–49.

ANONYMOUS. 1927. Value of rice by-products for laying hens. Arkansas Sta. Bull. 221: 37–46.

ANONYMOUS. 1930. Experiments with poultry. Louisiana Sta. Bien. Rpt. 1928-29: 47–49 pp. *Cited in* U. S. Dept. Agric. Exper. Sta. Rec. 63: 364–365. 1930.

ANONYMOUS. 1930. Eggs in the making. American Poultry Journal **61**: 3. (Editorial)

AMON, VALENTIN G. 1930. Studies on the influence of free choice of feed in poultry feeding. The Philippine Agriculturist **19**: 445–459. *Fig. 1–2; charts 1–4.*

BROOKS, W. P., F. R. CHURCH, AND S. B. HASKELL. 1905. Poultry experiment. Massachusetts Sta. Rept.: 43–46.

CRUZ, FLORENTINO F. 1918. Effect of certain feeds on growth and production of eggs and meat by poultry. The Philippine Agriculturist and Forester **7**: 44–54.

FRONDA, F. M. 1928. The seasonal distribution of egg production: The normal egg production curve. The Philippine Agriculturist **17**: 25–32. *Charts 1–2.*

FRONDA, F. M. 1932. Comparative studies of the value of different mash mixtures for egg production. The Philippine Agriculturist **21**: 96–105. *Chart 1.*

HENRY, W. A., AND F. B. MORRISON. 1929. Feeds and feeding. Abridged. 6th ed., viii + 440 p., 114 fig. Milwaukee, Wisconsin: C. N. Caspar Co.

HOLST, W. F., AND W. E. NEWLON. 1931. Poultry feeding: Principles and practice. Revised. California Agric. Exper. Sta. Bull. 417: 1–50 *Fig. 1-5.*

KATAYAMA, I. 1924. Über die verdaulichkeit der futtermittel bei hühnern. *Imp. Agr. Exp. Sta.* (*Japan*) *Bull.* 3, pp. 1–78. *Cited in* MORLEY A. JULL, 1930. Poultry husbandry. ix + 639 p. New York: McGraw-Hill Book Company, Inc.

KNAPP, S. A. 1900. Rice culture in the United States. U. S. Dept. Agric. Farmers' Bull. 110: 5–28.

LAMON, H. N., AND A. R. LEE. 1929. Poultry feeds and feeding. 247 p., 23 fig. New York: Orange Judd Publishing Co.

LIPPINCOTT, A. W. 1927. Poultry production. 4th ed., viii + 602 p., 205 fig., 2 pl. Philadelphia: Lea and Febiger.

MAMARIL, JULIAN. 1925. The supplementary actions of some naturally occurring feeds for feeding chicks. *Abstract in* The Philippine Agriculturist **13**: 409.

MUSSEHL, F. E., J. W. CALVIN, D. L. HALBERSLEBEN, AND R. M. SANDSUEDT. 1921. Nutrient requirements of growing chicks: Nutritive deficiencies of corn. Jour. Agric. Res. **22**: 115–149. *Fig. 11.*

PAJE, PEDRO S. 1927. The cost of raising pullets under conditions existing in the College of Agriculture. The Philippine Agriculturist **16**: 34–48. *Chart 1.*

RESANANDA, THONGDEE. 1924. Determination of the best season for hatching eggs in the Philippines. The Philippine Agriculturist **13**: 81–90.

TUASON, NICASIO A. AND F. M. FRONDA. 1924. Studies on the Philippine poultry feeds: I. Availability and palatability. The Philippine Agriculturist **12**: 459–464.

WAITE, ROY H. 1929. Poultry science and practice. ix + 433 p., 337 fig. New York: McGraw-Hill Book Co.

TABLE 1

Showing the average weekly weight of chicks in the three sets

AGES	LOT I (CORN FED LOT)		LOT II (PALAY FED LOT)		LOT III (CORN AND PALAY FED LOT)	
	Number of birds	Average weight	Number of birds	Average weight	Number of birds	Average weight
		grams		*grams*		*grams*
1 day old	190	26.0	190	25.8	190	25.9
1 week old	188	31.6	186	32.9	177	32.3
2 weeks old	178	41.5	177	41.4	158	40.8
3 " "	168	57.5	152	53.7	145	56.5
4 " "	163	71.8	137	63.2	141	68.2
5 " "	154	93.1	114	75.5	132	86.0
6 " "	147	122.4	104	96.2	123	117.4
7 " "	144	144.9	102	109.8	119	135.6
8 " "	135	174.1	95	138.4	104	170.0
9 " "	131	208.6	89	168.6	102	199.6
10 " "	128	253.9	89	205.3	102	238.1
11 " "	128	292.7	87	250.3	101	285.3
12 " "	127	336.6	85	295.6	100	326.0

TABLE 2

Showing the average mortality of chicks in the three sets

PERIODS	LOT I (CORN FED LOT)		LOT II (PALAY FED LOT)		LOT III (CORN AND PALAY FED LOT)	
	Number of chicks	Mortality	Number of chicks	Mortality	Number of chicks	Mortality
		per cent		*per cent*		*per cent*
At hatch	190		190		190	
4 weeks ...	164	13.68	138	27.36	141	25.79
8 weeks [a] ..	141	7.93	97	26.08	115	6.38
12 weeks [b] ..	128	7.80	85	9.28	100	13.04
Total		29.41		62.72		45.21

[a] Rats killed 10 chicks in lot I, 5 chicks in lot II and 17 chicks in lot III.
[b] Rats killed 3 chicks in lot I and 3 chicks in lot II.

TABLE 3

Showing the average amount and cost of feed consumed by the chicks raised to 12 weeks old

PERIODS	FEED CONSUMPTION PER 100 CHICKS						COST OF FEED CONSUMED POR 100 CHICKS [a]					
	LOT I (Corn fed lot)		LOT II (Palay fed lot)		LOT III (Corn and palay fed lot)		LOT I (Corn fed lot)		LOT II (Palay fed lot)		LOT III (Corn and palay fed lot)	
	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
1- 4 weeks	10.9	11.2	11.1	10.9	11.8	11.9	0.46	1.83 [b]	0.52	1.85	0.53	1.91
4- 8 weeks	21.7	22.7	21.8	21.3	25.5	25.0	0.91	1.31	0.98	1.32	1.13	1.50
8-12 weeks	44.4	44.0	50.7	49.7	47.6	46.8	1.87	2.54	2.38	3.07	2.09	2.80
Total	77.0	77.9	83.6	81.9	84.9	83.7	3.24	5.68	3.88	6.24	3.75	6.21
Total amount and cost of feed consumed	154.9		165.5		168.6		8.92		10.12		9.96	

[a] The prices of the different feeds used upon which computations were based were as follows: corn meal, ₱0.042 a kgm.; palay meal, ₱0.047 a kgm., and shrimp meal, ₱0.121 a kgm.

[b] The cost of eggs consumed by each lot during the first two weeks was included under the cost of mash.

TABLE 4

Showing average weight of pullets raised to 24 weeks old in the two sets

AGES	LOT I (CORN FED LOT)		LOT II (PALAY FED LOT)		LOT III (CORN AND PALAY FED LOT)	
	Number of birds	Average weight	Number of birds	Average weight	Number of birds	Average weight
weeks		*grams*		*grams*		*grams*
12	39	322.2	39	303.0	39	305.0
13	39	421.5	39	399.8	39	414.4
14	39	486.4	37	450.7	39	461.5
15	38	547.1	35	528.5	39	549.2
16	38	614.9	35	592.2	39	617.9
17	38	666.3	35	656.0	39	671.7
18	38	722.3	35	720.3	39	729.1
19	38	774.2	35	764.8	39	775.1
20	38	821.7	35	801.9	37	814.3
21	38	900.9	32	847.2	36	853.9
22	38	955.5	30	889.7	36	897.8
23	38	1017.9	27	931.5	34	962.1
24	38	1003.4	24	937.6	33	999.6

TABLE 5

Showing the average mortality of pullets in the two sets

ITEMS	LOT I (CORN FED LOT)		LOT II (PALAY FED LOT)		LOT III (CORN AND PALAY FED LOT)	
	Number of pullets	Mortality	Number of pullets	Mortality	Number of pullets	Mortality
		per cent		*per cent*		*per cent*
Number of pullets at beginning ..	39		39		39	
Number of pullets at close	38		24		33	
Number of pullets died	1		15		6	
Percentage of mortality		2.56		38.46		15.38

TABLE 6

Showing the average amount and cost of feed consumed per 100 pullets in the two sets

PERIODS	CONSUMPTION PER 100 BIRDS						COST OF FEED CONSUMED PER 100 BIRDS [a]					
	LOT I (Corn fed lot)		LOT II (Palay fed lot)		LOT III (Corn and palay fed lot)		LOT I (Corn fed lot)		LOT II (Palay fed lot)		LOT III (Corn and palay fed lot)	
	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
12-16 weeks	69.7	70.9	68.4	69.5	70.1	70.3	2.93	4.10	3.22	4.30	3.12	4.20
16-20 weeks	82.0	82.6	82.9	82.3	72.6	71.8	3.39	4.77	3.91	5.08	3.23	4.29
20-24 weeks	98.1	96.9	94.2	93.5	93.8	95.7	4.12	5.60	4.43	5.78	4.17	5.72
Total	249.8	250.4	245.5	245.3	236.5	237.8	10.44	14.47	11.56	15.16	10.52	14.21
Total amount and cost of feed consumed	500.2		490.8		474.3		24.91		26.72		24.73	

[a] The prices of the different feeds used upon which computations were based were as follows: Corn meal, ₱0.042 a kgm; palay meal, ₱0.047 a kgm.; and shrimp meal, ₱0.121 a kgm.

TABLE 7

Showing the data on cost and gain

ITEMS	LOT I (CORN FED LOT)	LOT II (PALAY FED LOT)	LOT III (CORN AND PALAY FED LOT)
Initial weight at the end of the 12th week	32.2 kgm.	30.3 kgm.	30.5 kgm.
Final weight at the end of the 24th week	100.4 "	93.8 "	100.0 "
Increase in weight	68.2 "	63.5 "	69.5 "
Value of the increase in weight at ₱0.60 per kgm.	₱40.92	₱38.10	₱41.70
Cost of feed consumed	24.91	26.72	24.73
Gain less cost of feed consumed	16.01	11.38	16.97

TABLE 8

Showing maturity of the pullets in the two sets

ITEMS	LOT I (CORN FED LOT)	LOT II (PALAY FED LOT)	LOT III (CORN AND PALAY FED LOT)
Number of pullets raised to 24 weeks of age	38	24	33
Age when first egg was laid	157 days	159 days	160 days
Number of pullets laying at 24 weeks of age	10	3	6
Percentage maturing	26.31	12.50	18.18
Number of eggs laid at end of 24 weeks	27	14	20
Value of eggs laid at the end of 24 weeks at ₱0.03 each	₱0.81	₱0.42	₱0.60

TABLE 9

Showing the monthly percentage of egg production of each lot

MONTHS	LOT 1 (CORN)	LOT 2 (PALAY)	LOT 3 (CHECK)
	per cent	*per cent*	*per cent*
September	30.77	32.59	28.27
October	37.72	29.56	30.89
November	37.31	31.85	39.87
December	39.95	42.77	40.94
January	46.28	37.75	43.55
February	45.23	46.28	46.29
March	38.71	44.21	43.67
April	37.69	40.25	38.85
May	30.89	36.85	39.61
June	31.03	37.18	36.13
July	32.51	29.90	31.23
August	28.04	32.13	36.13
Average	36.34	36.77	37.95

TABLE 10

Showing the actual number of eggs produced and feed consumed by the birds in the three lots

	LOT 1 (CORN)	LOT 2 (PALAY)	LOT 3 (CHECK)
Total number of eggs laid	3,465	3,588	3,572
Average weight of eggs, in grams [a]	41.4	41.3	40.5
Average yearly production per hen	132.6	134.4	139.0
Total grain consumed, in kgm.	332.8	379.7	386.9
Total mash consumed, in kgm.	325.7	370.4	365.4
Average grain consumed per hen during the year, in kgm.	12.4	14.1	14.4
Average mash consumed per hen during the year, in kgm.	12.1	13.8	13.6
Average feed consumption per hen during the year, in kgm.	24.5	27.9	28.0

[a] Number of eggs weighed in each lot, 300.

TABLE 11

Showing the relative cost of feeds used and of eggs produced

	LOT 1 (CORN)	LOT 2 (PALAY)	LOT 3 (CHECK)
	pesos	*pesos*	*pesos*
Total value of eggs produced @ 4¢	138.60	143.52	142.88
Total value of feeds consumed [a]	44.89	48.85	49.54
Profit above cost of feeds	93.71	94.67	93.34
Value of eggs produced per hen @ 4¢ each .	5.13	5.33	5.30
Value of feed consumed per hen	1.66	1.81	1.84
Value of eggs produced above cost of feeds per hen	3.47	3.52	3.46
Cost of feeds to produce one dozen eggs	0.259	0.272	0.277
Total cost of producing one dozen eggs	0.432	0.453	0.461
Net income from different lots [b]	63.78	62.10	60.31

[a] At ₱0.068 per kilogram, corn lot.
At 0.065 per kilogram, palay lot.
At 0.066 per kilogram, check lot.

[b] If the cost of feeds consumed represents 60 per cent of the total cost of production.

TABLE 12

Showing average weight and growth of hens, and the percentages of mortality

	LOT 1 (CORN)	LOT 2 (PALAY)	LOT 3 (CHECK)
Total weight of hens at the beginning of the experiment, in grams	35,100.0	34,600.0	34,025.0
Number of hens at the beginning of the experiment	27	27	27
Average weight of hens at the beginning of the experiment, in grams	1,300.0	1,281.5	1,260.2
Total weight of hens at the close of the experiment, in grams	40,325.0	37,750.0	36,500.0
Number of hens at the close of the experiment	26	26	25
Average weight of hens at the close of the experiment, in grams	1,551.0	1,451.9	1,460.0
Percentage increase in weight	19.30	13.30	15.86
Percentage of mortality	3.70	3.70	7.41

TABLE 13

Showing the fertility and hatchability of eggs

	LOT 1 (CORN)	LOT 2 (PALAY)	LOT 3 (CHECK)
Number of eggs incubated	243	243	243
Percentage of infertile eggs [a]	2.65	6.57	5.11
Percentage of D_1 [b]	38.32	35.66	43.44
Percentage of D_2 [c]	3.74	7.24	4.61
Percentage of D_3 [d]	5.34	7.09	5.60
Percentage of P [e]	1.17	1.99	1.55
Percentage of hatch	48.77	41.42	39.67

[a] All computations were based on the total number of eggs set.
[b] D_1 Germs that died during the first week of incubation.
[c] D_2 Germs that died during the second week of incubation.
[d] D_3 Germs that died during the third week of incubation.
[e] P Eggs pipped, but did not hatch.

ABSTRACT [1]

Comparative digestibility in vitro of Philippine bananas. WENCESLAO S. FIGUEROA. (*Thesis presented for graduation, 1933, with the degree of Bachelor of Agriculture from the College of Agriculture No. 384; Experiment Station contribution No. 956.*)—The object of this study was to compare the digestibility of starch and protein in vitro of four varieties of Philippine bananas; namely, Latundan, Inarnibal, Galamay Senora, and Tampolin using salivary amylase and diastase for starch and trypsin and pepsin for protein.

The percentages of starch and protein digested by each enzyme was determined fifteen minutes, one hour, two hours and three hours after the addition of the enzyme in each variety. In the control, sodium tungstate solution was added to prevent the action of the enzyme. The amount of starch digested was determined by analyzing the samples for nitrogen.

Arranged in the order of their starch digestibility using salivary amylase, Tampolin was first; Latundan, second; Galamay Señora, third; and Inarnibal, fourth. With diastase, Tampolin was first; Latundan and Galamay Señora, second; and Inarnibal, third.

Arranged in the order of their starch digestibility, Tampolin was first; Latundan, second; Galamay Señora, third; and Inarnibal, fourth.

Arranged in the order of their protein digestibility using pepsin, Inarnibal was first; Galamay Senora, second; Latundan, third; and Tampolin, fourth. With trypsin, Inarnibal was first; Galamay Senora, second; Latundan, third; and Tampolin, fourth. With trypsin, Inarnibal was first; Galamay Senora, second; Latundan, third; and Tampolin, fourth.

Arranged in the order of their protein digestibility, Inarnibal as first; Galamay Senora, second; Latundan, third and Tampolin, fourth.

Abstract by Lazaro S. Gonzales

[1] Abstract prepared as part of required theme work in English 3a, College of Agriculture.

KERNELS

"CORN FROM THE SHEAVES OF SCIENCE"

Sugar cane bagasse added to clay loam soil in pots was found to be harmful to young sugar cane plants, the detrimental effects being almost proportional to the amounts used. The harmful effects of the bagasse diminished with the degree of its decomposition. But the plants given no bagasse were better developed than the plants supplied with bagasse decomposed 75 days in the soil in pots. The harmful effects of the bagasse were fully neutralized by the addition of ammonium sulfate or horse manure and ammonium sulfate.

Pullets are just as good as hens as the source of eggs for the foundation stock.

In using Ammo-Phos fertilizer to get the maximum profit on rice it should not be applied to the field at a rate higher than 150 kgm. per hectare. In using ammonium sulfate, 100 kgm. per hectare is the maximum amount.

A study of the breeding habits of cattle in the Department of Animal Husbandry showed that cows exhibit a varying degree of fertility, some being faster and others slower in producing calves. The length of gestation period, however, was found to vary little, the average being 284 days.

Nagoya chickens are less resistant to the ill effects of local conditions, yielding more easily to disease and unfavorable weather than the Los Baños Cantonese.

Histological studies on the Berkjala pigs verified the observation that these pigs do not become sexually mature until they are 15 weeks old.

Fertilizing tests showed that cultures treated with either ammonium sulfate or a combination of ammonium sulfate and potassium sulfate gave relatively low yields of nodules and of total nitrogen, and in no case did they yield higher than the control (unfertilized). On the other hand, cultures that were treated with either superphosphate or potassium sulfate or both fertilizers yielded better than the control.

CURRENT NOTES

Of the many uses of edible soy meal, which has been produced on an industrial scale in Austria for five years, its application as a food for diabetics has recently been placed on a new basis. It was known that no starch is found in the 20 to 22 per cent of carbohydrates in the purified soy meal. Later analyses have shown that an average of only five to six per cent of sugar-forming substances (calculated as sucrose) is present in purified soy beans. The rest of the carbohydrates, consisting of stachyose, 5.66 per cent, araban, 4.83 per cent, and galactan, 6.18 per cent is harmless to diabetics. By the addition of the necessary technical baking supplements to edible soy meal, a bread has been successfully, produced which, on the basis of C. Noorden's investigations dealing with its value in metabolism experiments, shows only one-fourth as much sugar-forming substance as normal bread. In taste and appearance this bread comes so near to ordinary whole-grain bread that it can scarcely be distinguished from it. Moreover, there is the practical advantage that this new bread, now being manufactured for diabetics on a factory scale, is markedly cheaper than most of the baked products hitherto used by diabetics.

Ind. & Engin. Chem. News Ed., Vol. XI, No. 23, 1933, p. 347.
Reprinted in *Tropical Agriculture*, March, 1934.

Dry atmosphere and adequate ventilation are necessary for ripening and for the storage of mangoes. Carbon dioxide gas has a retarding effect on the process of ripening.

Mature mangoes can be made to ripen in 20-25 days at between 5-10°C. The ripening can, if necessary, be hastened by raising the temperature to 25-30°C. At 0°C. fully ripe mangoes can be stored in good condition for 3-5 weeks.

Ripe mangoes and sliced pulps preserved in syrup keep well for 3-4 months. Although the edible quality of the fruit can be preserved for a further period, yet the pulp becomes very soft and thus suffers in quality. Slight acidification of the syrup with vinegar, tartaric acid, or citric acid further helps the preservation. Presence of a small quantity of sulphur dioxide in the syrup helps to preserve the mango in perfect colour, shape, and edible quality for over a year.

The combined evidence obtained from the present research show that mango can be preserved as fresh fruit for 7 weeks from the date of plucking. When stored in sugar syrup plus an antiseptic, the fruit can remain sweet for over a year.

Agriculture and Live-stock in India, January, 1934

In order to secure the most profitable return peanuts should be grown in a sequence or rotation with other crops preferably once in every three or four years.

Though the crop, in common with most other legumes, has the power of collecting the free nitrogen from the air and storing it up in small nodules on the roots, its value in this direction is not so great as cowpeas, velvet beans, and other legumes of similar growth, since in harvesting much of the root system of the peanut with adherent nodules is removed from the soil. The amount of nitrogen, however, added to the soil by the peanut crop is considerable and well illustrated in the improved growth of following crops, such as maize or potatoes.

In all crop sequences it is advisable at least once in three or four years to plough under a growing crop to maintain or build up the humus and decaying organic matter in the soil.

Queensland Agricultural Journal, February, 1934

Manuring at one time meant the addition of anything which led to the amelioration of the land, but nowadays it is more general to consider a *manure* to be a substance which makes good a shortage of a mineral plant food, whilst any material that improves the mechanical condition or texture of the soil, or corrects the excessive acidity or alkalinity, is known as a *soil amendment.* For instance, superphosphate which supplies phosphorus to the crop is a *manure;* lime, which improves the texture of the land, is a *soil amendment;* whilst farmyard manure is both a *manure* and a *soil amendment.*

The Journal of the Department of Agriculture of South Australia, February 15, 1933

The Department recommends tomato growers to stake their early tomatoes, and home gardeners to stake all their plantings.

A report from Antigua shows that in that Island, also, staking tomatoes pays. The yields per plot of staked and unstaked to-

matoes were 159 pounds and 85 pounds respectively, and those over two inches in diameter and entirely free from blemishes were 35 per cent and 29 per cent respectively.

Agricultural Bulletin of Bermuda, Department of Agriculture, November, 1933.

Reprinted in *The Journal of the Jamaica Agricultural Society*, January, 1934.

COLLEGE AND ALUMNI NOTES

On February 10, 1934 Dr. Toyohiko Kagawa addressed the Student Body on the value of co-operation among farmers. Doctor Kagawa has an international reputation as a lecturer and writer on social welfare and religion. In Japan he is known also as a remarkably devoted and practical worker among the poorest and most neglected people of the city and the country. It has been said of him that he has tried to follow literally the teachings of Christ. He is a prolific writer and prodigious worker.

In his address before the Student Body he gave not only the principles of co-operation as it is being introduced among the farmers in Japan but data on what he had done in this work and what could be done. It was a most illuminating address.

While in the Philippines Doctor Kagawa studied the work of the bureaus of health, prison, education and agriculture and commerce and gathered voluminous statistics, besides giving some seventy addresses.

Luang Inkasrikasikarn (Iang Chandrastitya B.S.A. '21) was a most welcome Campus visitor the last week of March. Luang Inkasrikasikarn (this title was bestowed upon him for work in agriculture in Siam) was on an official trip for the Siamese Ministry of Public Instruction in Formosa, Java and Sumatra. The study of progress in agriculture and agricultural education are the prime objects of his trip. His stay in the Philippines was purely personal, to see old college friends and the campus. Incidentally, he gathered information on some crops in which he is particularly interested.

Luang Inkasrikasikarn is now Director of the Experiment Station at Korat, Siam and Principal of the Agricultural Teachers Training School at the same place.

Former collegemates of Iang now on the faculty as well as his former instructors were most delighted to see the first Siamese graduate of the College, and one who is such a credit to his Philippine Alma Mater.

Agricultural Life made its appearance in February, 1934. This journal was received with a special welcome, as the editor, Dr. Toribio Vibar is one of our graduates and for some years was on the agronomy staff. With no family partiality, warmest praise is given to this latest journal. In contents it meets the agriculturist's needs. In arrangement it merits only commendation, and in appearance it is artistic and pleasing. May it become the farmers' "Daily Helper"! And may the day soon come when not to be a subscriber to *Agricultural Life* is to be counted among the old fogy farmers.

From a letter from Mr. George A. Kerr, Vice President and General Manager Philippine Cutch Corporation to Professor Yule the following tribute to the late Mr. Angel Africa is quoted: "In further relation to Mr. Africa we beg to say that he was held in very high esteem by his employers and the loss of not only his services are deeply regretted but also his association as a scholar and a gentleman."

Tropical Life, London, devotes in each issue one page or more to the feature, " 'Tropical Life' Friend." This "friend" is one who by achievement has proved himself a friend of Tropical Agriculture. The "friend" in the January, 1934 number is our own friend Mr. Gaudencio M. Reyes, B.S.A. '20.

Under "Recent Bibliography" in *International Review of Agriculture,* Rome, the article "Distribution of Mosaic and Fiji diseases in sugar cane stalks; effects of these maladies on the germination of the eyes and transmission of the viruses by pin pricks" by G. O. Ocfemia, Evaristo A. Hurtado and Crispiniano C. Hernandez is listed. This article appeared in the November, 1933, number of THE PHILIPPINE AGRICULTURIST.

Under "Abstracts and Reviews" the January, 1934 number of *Lingnan Science Journal,* Canton appear brief abstracts of "A study on the comparative economy of egg production of the Nagoya and of the Los Baños Cantonese breeds of fowls" by Ladislao G. Martir, and "Comparative studies on the growth and maturity of Los Baños Cantonese and Nagoya chickens," by Telesforo Tioaquen.

Both of these articles were published in THE PHILIPPINE AGRICULTURIST, Volume 22, 1933.

The nintieth regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Poultry Building, College of Agriculture, on February 15, 1934, at 7:30 p. m.

The following papers were read and discussed.

"The proximate composition of the seed and oil of Philippine oil bearing seeds: I. *Pongamia pinnata* Merr."

By Mr. Florencio A. Soliven

"Study of clear length of Molave (*Vitex parviflora* Juss.) trees in stand."

By Mr. Justino Seguerra

"The use of chemicals in curing and fermenting tobacco."

By Dr. Eulalio Baltazar

At the ninety-first regular scientific meeting on March 8, 1934, at 7:30 p. m. the following papers were read and discussed.

"Studies on the blood of different breeds of cattle with special reference to adaptability to local conditions."

By Mr. Nicomedes C. Reyes

"Comparative resistance of some treated and untreated American woods against termites and decay."

By Mr. Ricardo Buhay

"Soils surveying in China"—Illustrated.

By Dr. Robert L. Pendleton

The following words of praise on *Preparation of Scientific and Technical papers* in a recent letter from A. Lincoln Fellows, Senior Irrigation Engineer, Division of Irrigation, U. S. Department of Agriculture, located at Berkeley, California, were gratifying to the authors, Trelease and Yule.

"I wish that each member of this Division who writes for publication, including myself, had been furnished with a copy of the book when it first came out, and that he had been required to conform, in general, with its teachings. In other words, I think it admirable and that a copy should be at the elbow (with its precepts well established in the mind) of each of our men who aspires (or is obliged) to write for publication."

The Baker Memorial Scholarship aid was awarded this year to Maxima B. Mulimbayan. Of the three applicants she ranked highest in the qualifications prescribed by the original Baker Memorial Committee. These qualifications are: "Character, promise of future usefulness and scholarship." At the end of the semester ending in October, 1933 Miss Mulimbayan had completed 219 units with

an average rating of 2.84. Because of unavoidable delay in completing her thesis Miss Mulimbayan will not be graduated until June.

Self-supporting senior students who wish to compete for this scholarship should file their applications with the Secretary at the beginning of the second semester so the committee which consists of the Dean, Secretary and a head of a department will have time to study the applicants. Grades form only one requirement. Moreover, self-supporting students should begin in their freshmen year to plan to compete for this material help which is very welcome in their senior year.

The Aggie Pen Club has the distinction of making the only contribution to the Baker Memorial Scholarship Fund received this year. From the profits of 1933, *Farm Leaves* the Club on March 5, 1934 donated ₱17 to the Fund. This makes the total Fund ₱2,781.29.

The surplus *Farm Leaves* are now in sale at the English Office for 20 centavos a number. The receipts will be given to the Baker Memorial Fund.

Because of reduction in the English staff no adviser was available for the Aggie Pen Club last year and it was temporarily suspended. The same condition prevails this current year.

The Secretary's office reports that the following College of Agriculture students received degrees on March 20, 1934.

Ad Interim

Bachelor of Agriculture

1. Wenceslao Figueroa	(June)	5. Felipe T. Aala	(October)
2. Guillermo O. Palis	"	6. Daniel M. Buñag	"
3. Generoso Tanseco	"	7. Napoleon A. Danao	"
4. Juan P. Tecson	"	8. Victoriano J. Madrid	"

Bachelor of Science in Agriculture

1. Isidro V. Abrenica	(June)	12. Miguel G. Alba	(October)
2. Valeriano Borja	"	13. Gabino C. Arriola	"
3. Pedro D. Collado	"	14. Engracio E. Basio B.Agr. (Supp.)	"
4. Thuan Komkris	"	15. Porfirio R. Carandang	"
5. Melecio T. Legaspi	"	16. Maximino S. Cortez	"
6. Cornelio O. Mariano	"	17. Donato Dalupang	"
7. Gregorio Monegas	"	18. Luis D. Fadullon	"
8. Silvestre A. Sabio	"	19. Bartolome J. Javier	"
9. José B. Utzurrum	"	20. Julito Marcos	"
10. Valeriano Valenoba	"	21. Ricardo T. Marfori B.Agr. (Supp.)	"
11. Pastor Villanueva	"	22. Sotero P. Penuliar	"
		23. Pantaleon H. de los Reyes	

Bachelor of Science in Sugar Technology

Virgilio C. Bustos (October)

Completing work in March, 1934

Bachelor of Agriculture

1. Felix J. Arriola
2. Porfirio V. Barlaan
3. Jose L. Bayan
4. Pedro C. Gabertan
5. Flavio G. Gonzalez
6. Teodoro T. Gonzales
7. Laureano R. Lucas
8. Osmundo Mondoñedo
9. Juan L. Naron
10. Sotero R. Roque
11. Apolonio Serquenia
12. Maximo R. Tamayo

Bachelor of Science in Agriculture

1. Claudio N. Adan
2. Isidro M. Aguanta
3. Domingo M. Alaba
4. Victorio P. Antonio
5. Alejandro R. Apacible
6. Nazareno A. Apellido
7. Manuel H. Asuncion
8. Pedro P. Asuncion
9. Vicente Asuncion
10. Victorino S. Borja
11. Adolfo Castillo
12. Gregorio S. Chan B.Agr. (Supp.)
13. Ruperto Denoga
14. Dioscoro N. Diapo
15. Manuel L. Dinglasan
16. Graciano D. Espinueva
17. Cirilo S. Esperidion
18. Cesar J. Fernandez
19. Antonio P. Flores
20. Juan B. Fontanilla
21. Victoriano M. Gagolinan
22. Francisco Helardo
23. Agusto E. Kabigting
24. Benigno O. Legaspi
25. Armando M. Locsin
26. Fernando Mabalay
27. Manuel P. Mallonga
28. Cesar T. Mamon
29. Porfirio R. Manacop B.Agr. (Supp.)
30. Nicanor C. Manipula
31. Dennis Molintas
32. Isaac N. Nuestro
33. Alejandro O. Obillo
34. Emilio S. Ocampo
35. Teodolfo P. Oliquino
36. Amado B. Paggao
37. Narciso N. Pepito
38. Glicerio A. Pescador
39. Marcelino B. Plurad
40. Thonghaya Punyasingha
41. Celestino G. Reantaso
42. Fidel F. Reyes
43. Nicomedes G. Reyes
44. Norberto Rivero B.Agr. (Supp.)
45. Rafael R. Roces Jr.
46. Bernardo Sabalburo
47. Tranquilino V. San Pedro
48. José K. Santiago
49. Theodore G. Schuck
50. Narciso S. Sibal
51. Teodorico Tabayoyong
52. Alfonso L. Tecson
53. (Miss) Iluminada V. Torres
54. Isidro Villafuerte
55. Pedro Y. Yatar

Bachelor of Science in Sugar Technology

1. Oscar A. Alcantara
2. Abelardo L. Bantug
3. Abelardo L. Dizon
4. Gregorio B. Makabali
5. José B. Santos
6. Ernesto Villareal

Certificate in Agricultural Education

1. Moises Angel, B.S.A. '33
2. Gabino Arriola, B.S.A. '34
3. Gregorio Chan, B.S.A. '34
4. Dennis Molintas, B. S. A. '34
5. Bernardo C. Sabalburo, B.S.A. '34
6. Sabas P. Tangco, B.S.A. '33

The Secretary reports the following students as having received grades of distinction at the close of second semester of the academic year, 1933-34; grades based on the final ratings in March, 1934.

RANK	NAME	AVERAGE RATING [1]	ACADEMIC LOAD [2]	CLASS
1st	Lopez, Francisco R.	1.50	20	2nd Year, B. S. S. T.
2nd	Las Marias, Crispin	1.66	18	3rd Year, B. S. A.
3rd	Alconcel, Trinidad	1.70	17	1st Year, B. S. A.
4th	Mondoñedo, Osmundo	2.00	17 [3]	4th Year, B. Agr.
5th	Santos, Hilario J.	2.09	22	2nd Year, B. S. A.

[1] The average rating was computed by multiplying the final rating obtained by the student in each course by the number of units carried by such course and dividing the sum of the products by the total number of units carried by the student.

[2] Only students carrying regular loads (minimum of 15 units for working students and 20 units for regular students) were considered.

[3] Excluding credits on thesis.

The annual athletic program of the U. P. Los Baños Colleges was given on the evening of March 10, 1934. The program follows:

Part I

1. Song—U.P. Band—By the Audience.
2. Remarks and announcement of results of the U.P. Manila vs. U.P. Los Baños Championship Games—Prof. P. Dacanay, Member of the Los Baños Sub-Board of Athletic Management.

Part II

1. Locomotive Yell—By the Audience.
2. Remarks—Physical Director, University of the Philippines.
3. Announcement of the results of the U.P. Los Baños Intramural Championship Games—Lt. A. Martelino, Member of the Los Baños Sub-Board of Athletic Management.

Part III

Distribution of Awards and Prizes.

Intramural Games—Dean B. M. Gonzalez.

a. 1. Basket ball—C.A. '34 (Seniors).
   2. Volley ball—School of Forestry.
   3. Football—C.A. '36 (Sophomores).
   4. Tennis—C.A. '34 (Seniors).
   5. Carnival Relays—C.A. '34 (Seniors).

b. Ribbons for winners Carnival Relays—Lt. A. Martelino.
c. Awards of Medals—P.A.A.F.—Prof. H. Cuzner.
d. College Letters—Prof. P. Dacanay.
e. Varsity Letters—Prof. R. B. Espino, President, Los Baños Sub-Board of Athletic Management.
f. Certificates (1. College—Prof. R. B. Espino.
(2. Varsity—Prof. C. C. Bartolome.
g. Varsity Sweaters—Prof. C. C. Bartolome.

Part IV

1. Song—A.R.F.—By the Audience.
2. Closing Remarks—Dean B. M. Gonzalez.
3. Show—Slow moving pictures of the best performers in field and hurdles events of the World Olympics, Los Angeles.

IN MEMORIAM

ANGEL AFRICA, B.Agr. '20; B.S.A. '22; M.S.A. '23.

Graduate Assistant (physics) College of Agriculture 1920-1925. Instructor in physics and chemistry in Zamboanga Normal School 1925-1928. Chief Chemist, Philippine Cutch Corporation, Zamboanga 1928-1934.

Zamboanga, January 31, 1934.

GIVE FARMING A NEW VIGOR [1]

Our Independence Act has recently been approved by the United States Government. The formation of the Commonwealth is soon to begin. These most important events bring in new lines of thought, new food for thought. They are a challenge to us as Filipino citizens, to us in this College as scientists, as agriculturists. They are a challenge to our ability to look into the future.

We have come to a new era. We have come to the era of self-sufficiency, the era of economy. Now more than at any other time in our history there is need for reflection, for introspective analysis and for clear vision.

We must ponder on our economic problems. All citizens of this country are directly concerned with these problems. The business men, the manufacturers, the miners, the farmers are all affected. The politicians, the teachers and others are likewise concerned. Each of us is called upon to do something. Every one must give a hand in the building of a permanent structure for our nation. What can we do? What must we do?

As farmers, we should be thinking about what can be done to promote farming interest, to solve our farming problems. Much can be done along this line. As we know, scientific farming in the Islands is still in its infancy. The production must be increased, and at the least cost. Two or more plants must be produced where only one is now produced. Never has competition in marketing farm products been so keen. Our farming must be given a new vigor. "A word to the wise is sufficient."

Research is a means of finding solutions of our agricultural problems. It is a good thing that we have institutions devoted to agricultural research. It is fortunate that we have individuals devoting their time to research in agriculture. It is doubly fortunate that the government is encouraging research. Recently through the initiation of Governor General Murphy our National Research Council was established. All such organizations are needed. But, in the meantime, something else can be done.

The old precepts are still good, but they as well as new ones should be followed more vigorously. There should be proper selec-

[1] General contribution from the College of Agriculture No. 402.

tion and preparation of land. The seeds and other planting materials must be rigorously selected. The plants must be well cared for. Diseases and pests must be controlled. Weeds must be controlled. Philippine fields, plantations, orchards are far too weedy for good production. Fertilizers and manures should be used whenever and wherever needed. Irrigation water should be used if needed, and if it is available. Planting should be done at the right time and crops should be harvested at the right time. Co-operative marketing should be developed.

Select the right plant, the proper crop for the land and climate available. Mistakes in this may mean poor yield and a loss to the farmer. It may be possible to improve the soil. It may be possible to improve the aërial environment of plants. But it is expensive to do so. "An ounce of prevention is worth more than a pound of cure," is always sound advice.

It costs just about as much to raise a poor crop as to raise a good crop. It costs just about as much to raise a tree with low production as a highly productive one. Hence, select the seeds; select the planting materials. Choose the planting land with judgment. Waste no time, waste no labor on poor plants, poor soil.

Give the plants and the soil proper care. Part of the success in farming depends on proper management, on proper cultural treatment. A plant responds to good care. Whether young or old, its body is plastic and its life is easily swayed one way or another.

Control the diseases and pests. These are enemies of the crop plants. They are more or less prevalent at certain places. They may appear sporadically. Control them yourself, if possible. If not, appeal to the proper government entities for advice and help. The weeds may harbor diseases and pests. Control the weeds. They compete with the main crop for space, light, food and soil water.

There are worn-out soils. Add fertilizers and manures to these. Soil fertility is exhaustible. Years of cropping always result in the depletion of soil fertility. One mineral nutrient lacking in a soil always brings about a decrease in yield. The quality of the product is also improved by proper use of manure or other fertilizer. Progressive farmers are able to reap considerable profits from the use of manures and commercial fertilizers. Why not you!

Water is the main item in success in farming. It softens the soil. It brings plant nutrients into solution. Fertilizers are useless to plants unless in solution; they may even do harm. Water helps convey plant food. It helps convey mineral and nitrogenous substances in the plant body. It serves as a raw material in the manu-

facture of plant food. It gives form and quality to plants. It helps make the plant body rigid, the stem erect, the leaves expand, and the roots able to push their way into the soil. Therefore it should be supplied whenever needed. Like animals, like men, plants need water.

Observe the proper time to plant and the proper time to harvest. Thus, a good deal of trouble can be avoided, and a considerable increase in gain obtained. It is a wise rule to observe. Our markets are full of farm produce prematurely harvested. Hence, income is lessened. Open your eyes to these things and avoid losses.

Co-operative marketing is needed. Farm produce must have a good market. It must command a good price. It must not rot. It must not spoil. It must not be stored too long. There must be distribution, transportation. Every cent saved counts. It is painful, most painful, to lose the profit once it is in sight. Co-operative marketing eliminates the middleman. It brings the produce of the farm direct to the consumer. The farmer and the consumer are benefited. This is the experience in other countries. Why not in ours?

These precepts are old. But, they are as good as new. Followed properly, they will help our farming industry, the backbone of our national life, of our very existence and happiness. Attack farming with a new vigor. Today is the time. To-morrow may be too late.

Rafael B. Espino
Of the Department of Plant Physiology

In our century science is the soul of the prosperity of nations, and the living source of all progress. Undoubtedly, the tiring daily discussions of politics seem to be our guide. Empty appearances! What really leads us forward are a few scientific discoveries and their applications.

The Kalends of the Williams & Wilkins Company October, 1933

It is reported that Russia has over a thousand scientists working on problems of crop improvement.

Science News Letter May 12, 1934

TRAINING CATTLE AND CARABAOS FOR WORK [1]

VALENTE VILLEGAS
Of the Department of Animal Husbandry

WITH SIX TEXT FIGURES

Draft animals are a prime necessity on the farm. To provide an adequate supply of these animals is one of the important problems in an agricultural region. There may be an over-supply of cattle and carabaos but a shortage of satisfactory draft animals. For usually only a small percentage of any herd will qualify for work animals even with training. And an animal with good qualifications can be turned into a poor draft animal by wrong methods in training. The object of this paper is to give some suggestions on the training of work animals.

METHODS OF TRAINING

The farmer's practice. On small farms the training of animals for work is done as a matter of routine. As the number of animals belonging to a farmer is small, these animals not only receive good care and feeding, they also become docile and well-behaved. From birth, the young calves are handled a great deal, especially if their dams are used for milking purposes. At weaning time the calves are separated from their mothers and from this time on are staked in different parts of the field and thus learn to be led and driven with a rope. Such calves are accustomed to man and almost always turn out to be very obedient. Usually, at the age of about two years, a calf is trained to pull light implements as the bamboo harrow. At about this same age it is trained to be ridden. While being trained, a calf is made to pay with this light work for at least part of its feed. Next it is hitched to a plow, but only the lightest kind of plowing is done. When it is about three and a half years of age it is hitched to a cart and taught to pull and this completes its training as a work animal. The training is done gradually, each step being taken after the animal is considered to be well-broken to each kind of work. Because of the small size and relative weakness of a young animal it is natural that it can not offer much resistance, the result

[1] Experiment Station contribution No. 958. Circular No. 27. Received for publication May 3, 1934.

is that it submits soon to the will of the master and with little resistance learns its part as a draft animal. This method is highly recommended and has its definite place in farm management.

Ranch practice. The method described in this circular may be considered a rapid method of training animals for work. It can be especially applied in the training of a large number of carabao and ox steers on a ranch where the animals for work purposes are carefully selected for conformation and size. Such an animal properly trained for work commands a price approximately twenty per cent above that of an untrained animal.

THE TRAINER

To attain a reasonable measure of success, the trainer of work animals should possess certain qualifications for the service. There

Fig. 1.—A carabao under restraint while the ring is being placed in its nose after the septum has been punctured with the trocar.

are two very important attributes of a successful trainer. He should be physically sound and should have a natural liking for animals. Size and strength both will be to his advantage in controlling the actions, playful or otherwise, of an untrained animal. Agility is also necessary. A trainer should not be clumsy and slow in movement; if he is, he can not meet the exigencies that will arise in transforming a range animal into a work animal. Moreover, his agility must be coupled with alertness in mind and eye. Resourcefulness also is a characteristic of a trainer which can not be overestimated. He should be able to meet unforeseen situations. A trainer should also be cool-headed and patient. Irksome happenings during the training period are common but he must not let them annoy him. He should never for-

get that the animal is not expected to act as intelligently as he himself. The trainer should not only have a liking for animals but he should also have much knowledge of their habits.

THE TRAINING FIELD

To be able to carry on training work properly with the least danger to the trainer and the animal, it is advisable to set aside a field suitable for the purpose. A field which has been lying fallow for some time, measuring about 70 meters wide and 200 meters long, will be suitable for a training ground. The field should be flat, fairly smooth and free from stumps and mudholes. If the field is covered with a good sod of grass it is an advantage.

ANIMALS SUITABLE FOR TRAINING

If the effort and time in training or breaking cattle and carabaos to work are to be justified, it is important that animals to be subjected to training be of the right sort. An animal should possess certain attributes before it may be considered worth training. In the first place, the animal should possess size. At two and one half years of age a carabao may be considered of good size if it weighs approximately 400 kilograms; in the case of cattle, the weight at three and a half years should be about 310 kilograms. The second point to be considered is good conformation. Neither the animal that is lanky, upstanding and bony, nor the stocky, lowset, wide and clumsy-moving creature is favored in work stock. An intermediate type satisfies the demand in the conformation in a work steer or carabao. In cattle, Philippine-Nellore crossbreeds generally show the necessary qualifications for a work steer. Cattle having more than three-fourths of Nellore blood have a tendency to too bony a frame and are very light in the body; also they are refractory and disobedient. With carabaos, the best conformation is also obtained among the Philippine-Indian crossbreeds, those having more of the Indian blood are likely to be light in weight and not well muscled. The head of a work animal should be short and wide, the eyes full and bright. The horns should be medium in size and symmetrically placed on the head. A good head is desirable as it indicates feeding ability, good disposition and intelligence. The head and neck together should be raised high giving the animal a stylish and attractive appearance. The body should be well-developed. Its length should be in proportion to the height. The chest should be deep and fairly wide. A very wide chest makes an animal awkward in its movements. The ribs should be well-sprung and deep. The back should be relatively straight and wide, the loins short, wide and full and the rump wide,

muscular, long and level. Likewise, the hip and thigh should be muscular, wide and deep. Too much muscular development in this region, however, is characteristic of a slow-moving animal. The legs should be sound and well-placed; that is, they should be relatively straight, of good size and quality and set squarely at the four corners. The feet should be large, sloping, concave at the bottom and the halves should be placed close together, yet not overlapping. In action, the steps of the animal should be far reaching, regular and straight. Quick action indicates diligence.

As to age, an animal should be started in training when it is relatively plastic and submissive, but not too young to carry on the work on the farm without becoming stunted. A very young animal is too weak to stand the strain of the work in training so will become

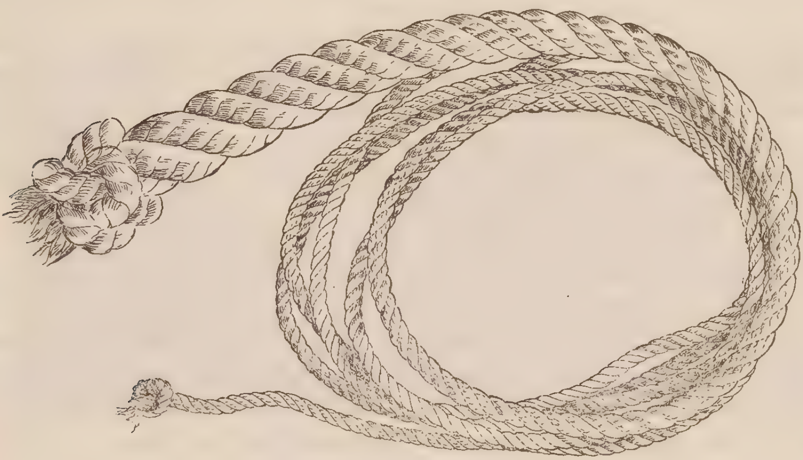


Fig. 2.—A driving line for work animals.

exhausted before the training period is over and harmful habits will be developed. But if an animal is too old it is stubborn and hard to control, thus giving many difficulties in its training. Carabaos two and a half to three years old are at the right age for training; cattle, owing to their smaller size, may be left until a year older before beginning their training.

GENERAL PROCEDURE

The procedure in training may be described briefly as follows: Soon after an animal is caught in the pasture, a ring is placed in its nose. In the ring, a rope is tied with which the animal is staked, led and driven. As soon as the animal is sufficiently trained to be driven around and has become reasonably tractable, the train-

ing shafts are placed on him. The animal is made to pull the shafts until he becomes accustomed to them. Then he is hitched to a plow. Owing to the training the animal has had with the shafts very little trouble is encountered when he is hitched to the plow. When plowing is mastered, the animal is hitched to a cart which he readily learns to pull owing to the experience he has had with the shafts and plow. The animal is then hitched to various farm implements like the harrow, clipper, etc. When he works obediently and easily in each of these, he may be considered a well-trained work bullock.

Ringing the animal

Soon after an animal that is to be trained or broken is caught and separated from the rest of the herd a ring is placed in its nose. In doing this the animal may be placed in a stock constructed for restraining purposes or if no such device is at hand the head of the animal may be securely fastened to a fence post with ropes as shown in figure 1. The nose is then held by the left hand and the septum between the nostrils is punctured with the trocar and cannula. The cannula is left in place, on one end of which the open ring is inserted and carried through the puncture as the cannula is removed. Finally, the ring is screwed on and the wound properly disinfected.

Of the two kinds of rings on the market, the copper ring, although more expensive, is recommended. It is the stronger and more durable of the two. The aluminum ring breaks easily. The ring should be of the right size; that is, it should be large enough to slide freely in the nose and yet not so large as to interfere in the feeding of the animal. The ring of a growing animal should be replaced when it becomes too small and tight in the nose.

Leading and driving

After ringing the animal, a rope measuring one and three-fourths inches in circumference and 12 meters long is tied to the ring. About three meters of the rope from the animal is cut off and passed through a loop at one end of the other piece of rope to prevent the whole length from undue twisting and breaking. With this rope the animal is staked on the grassy areas of the farm. During the first three or four days the animal will not feed well. It will have to be watered from a pail. Later, as it becomes accustomed to the rope and new surroundings it may be led to the watering place. And by this time, it grazes well on the pasture and day by day a change for the better may be observed in its behavior. It learns to be led as it is tethered at different places and as it is led to and from the watering place. The carabao becomes docile in a shorter time than the

ox. After training the animal to lead for about a week it may then be taught to drive. A driving line specially made for this purpose is used (see fig. 2). It is made of abaca or other plant fiber and is 5.75 meters long. One end of the line is enlarged so as to be more easily held by the trainer. The animal is driven ahead of the trainer and guided with the line which is tied in the nose ring and held on its left side. As the rope is struck on the body of the animal it is trained to turn to the right, by a steady pull on the line it is trained to turn to the left. To stop the animal the line is pulled slightly and at the same time the driver calls *ha, ha* (meaning to halt). Training on the line is given morning and afternoon covering towards the end of the training a distance of about one-half to one kilometer each time. At the beginning, the time of training and the distance traveled are short, being increased

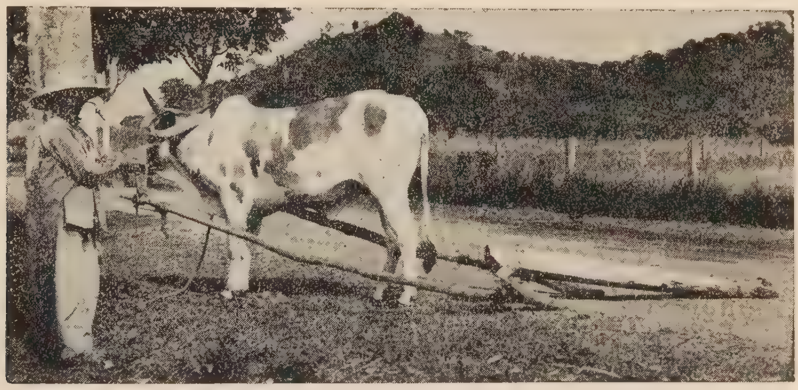


Fig. 3.—An ox being hitched in a pair of training shafts. Note the loop on the left shaft through which the yoke is placed; also, the banana stalk on the crosspiece.

gradually as the animal learns its lessons. The carabao is more readily taught to drive than the ox; two days being enough for the former but four or five days being required with the latter. For some time the ox moves from side to side while the carabao from the first goes forward steadily. Later, the animal may be trained to back by pulling hard on the rope and giving the command to back.

Training in shafts

Training shafts consist of two poles about 275 centimeters long with a crosspiece measuring about 60 centimeters placed about 45 centimeters from the base. A yoke is tied to the end of the right shaft. In hitching, the animal is held by the nose ring and the shafts are placed on the ground on each side of its body. The shafts

are raised up one by one and the yoke placed over the neck and securely fastened to the other shaft by a loop and the neck strap. At first two men are needed to do the hitching, one holding the animal and the other handling the shafts. In case the animal refuses to be hitched this way, it may be tied close to a tree before the shafts are put in place. Grade Nellore cattle are generally unruly so that it may be necessary to subject them to this treatment on first hitching them (see fig. 3). Training to pull the shafts will require two 10-minute periods a day for 10 days. At first the animal will find the new equipment strange and will run a short distance when first hitched. He soon slows down, however, and makes little further objection. Each day he shows familiarity with the shafts and the action is more agreeable. As the animal becomes steady in the shafts a large stalk of banana weighing about 25 kilo-

Fig. 4.—A steer being trained to pull a plow.

grams is placed on the crosspiece to train him to pull a load, and at the same time adapt his neck to greater pressure of the yoke. Of course, the animal should also be taught to stop and turn to the right or left during this phase of training.

Pulling a plow

When the animal is familiar with the training shafts it is hitched to a plow. A field of about 100 meters long is selected for training in plowing. It should be a tilled field so that the soil will be loose and relatively easy to work. The plow should be light, weighing around 18 kilograms and preferably made of iron. In hitching, lower the traces and yoke upon the animal, fastening the yoke in position with the neck band. With cattle it may be necessary at first to have a helper in hitching and to lead the animal. At first

the animal is made to drag the plow; then as progress is made the point of the plow is directed to a shallow depth which is made deeper until the normal cut in the soil is made. When at this depth the animal pulls the plow steadily he may be considered broken to the plow. On an average for plow training the carabao is made to plow a distance of 400 meters and the ox 200 meters at each time of two daily training periods. The carabao takes its training lessons readily and in about one week is usually sufficiently trained to do light plowing in the hands of a competent plowman. With the ox, various difficulties are encountered in this phase of the training. The principal reason is that the ox is of a more nervous temperament than the carabao, hence he may become confused at some little provocation. He may move forward on a zig-zag line and make an abrupt round-about face. The trainer must be patient

Fig. 5.—A carabao hitched to a training cart. Note the two driving lines which are used in the first part of training period.

and speak quietly and try to make the animal go slowly and prevent it from lying down, which it will do if urged forward vigorously, when in state of nervous confusion. It is important to remember that very light work should be given in the early part of the training period, the amount to increase gradually as the animal shows improvement. One rule in training is to close the work each time with an act well performed. This rule should be strictly adhered to with the ox and carabao in the plow training. For example, if an animal hitched to the plow happens to turn around at the closing of the training, then the work should be continued until he can be halted properly. Grade Nellore cattle do not submit as readily as the carabao in the plow work. So after three weeks training with the plow it is advisable to give the animal a change by hitching him in

a cart. After he has become accustomed to cart pulling return him to the plow. Usually, in this second period the ox readily does the work. With the average ox the time required to break or train it for ordinary farm work is about two and one-half months from the time it is first taken from the pasture.

Pulling a cart

The training cart shown in figure 5 is simple in construction, small in size but strongly built. Its weight is approximately 330 kilograms. Owing to the training processes the animal has gone through, the shafts of the cart may be lowered over it without difficulty. But there should be two men to hitch the animal, one holding it by the ring while the other lowers the shafts and yoke on it. As soon as the neck strap has been fastened the animal should be driven with the trainer and helper in the cart. Two lines are held by the trainer by which the animal may be guided or stopped. The line on the right side of the animal is pulled forward or to the side by the helper if the animal stubbornly refuses to obey the commands or signals of the trainer. Both the ox and the carabao will run a short distance on being made to pull a cart for the first time. For three or four days the work is done in the training field. Then the cart may be taken to the road. The noise of the cart wheels on the surface of the road will frighten the animal. So for the first few times the trainer must hold the driving lines firmly so that the animal does not go at high speed or get from under his control. Training work in the cart should be done in the morning and afternoon daily. At first drive the animal a distance of 400 meters each training period. Each day the work is increased so that on an average the animal is out for about one hour each time. As soon as the animal can be controlled readily and shows steadiness in its action he may be driven to crowded places in the vicinity to acquaint him with people and traffic. His training in the cart is not considered complete until he can be driven with only one line. With the carabao, the training for cart work takes about 10 days, with the ox it takes much longer, about one month. Both the ox and the carabao can be broken to cart pulling more easily than to plowing. The rolling of the wheels seems to help the animal to move on, while the shafts on both sides of the animal appear to have a controlling effect on his behavior. The shafts also prevent the animal from making a quick turn to the side which he may readily do with the plow.

The total time covered in training a carabao from the day it is caught in the pasture until it is satisfactorily broken for plow and cart work is one and one-half months, an ox two and one-half months.

Pulling various implements

To make an ox or carabao an all-round work animal it is necessary that he be broken to pull various farm implements. The principal ones he should be hitched to and trained to pull are the harrow, pasture clipper, lawn mower, sled and hay baler. The

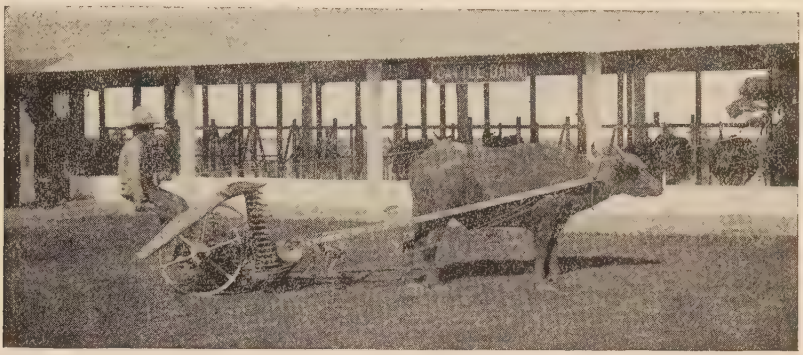


Fig. 6.—Training the carabao to work with other farm implements such as the clipper, etc.

carabao should be trained to work in puddled soil to fit him for the preparation of land for paddy rice. In a lumber district, the work carabao would be better fitted to haul rough lumber if he has had training for this work. The importance of training the carabao in threshing rice where this is still the practice in a region is also evident. Lastly, both the carabao and ox should be trained as riding animals. This can best be done after the animal has been trained in implement and cart work so that it is relatively tractable and less likely to throw off the rider during the training period.

A STUDY OF TEACHERS OF VOCATIONAL AGRICULTURE IN THE PHILIPPINES [1]

FRANCISCO M. SACAY
Of the Department of Agricultural Education

The teacher, as the director of learning, is a very important factor in the teaching-learning process. It is the teacher who largely determines the specific objectives to be attained. He sets up the proper learning situation by means of which desirable pupil activities may be brought about. He directs the pupils' activities in such order that learning may be accomplished most economically and effectively. In vocational agriculture this means that the teacher must have a thorough understanding of the aims and objectives of the course or courses which he is teaching. He must also know what to teach, since one cannot very well teach what he does not know. Therefore a teacher of agriculture must know farming. In addition he must know how to teach and be able to check up the results of his instruction. In other words, he must be a teacher. To fulfill the requirements of a teacher of agriculture he must know farming as well as teaching. The efficiency of instruction in vocational agriculture greatly depends upon the training and qualifications of the teacher in those two fields,—farming and teaching.

PURPOSE AND METHOD OF STUDY

The purpose of this study was to find out the technical and professional training and experience of teachers of agriculture in the Philippines. Other factors which influence the efficiency of teaching, such as age, occupational background of the teacher and variety of subjects taught were also included in the study. On the basis of the findings, certain implications were drawn concerning the program of training teachers of agriculture.

The data reported in this study were obtained by means of a questionnaire. Copies of the questionnaire were sent to the principals of different agricultural and rural high schools. Each principal was requested to have the blanks filled out by the teachers in

[1] General contribution from the College of Agriculture No. 403. Received for publication October 2, 1933.

his school. These blanks were then returned to the writer. The data were collected in 1931. The information on the number and variety of subjects taught by each teacher was obtained in 1932.

Replies were received from 149 teachers distributed in 18 schools of agriculture. Some of these teachers were teaching academic or purely intermediate subjects. They were not included in this study. Only those teachers who were teaching agriculture or related subjects were included. Those numbered 74. Of this number, 59 were teaching agricultural and related subjects of secondary level, and 15 were teaching intermediate agriculture in addition.

AGE OF TEACHERS OF AGRICULTURE

The age of teachers ranges from 23 years to 44 years, as shown in table 1. The modal age is 31 years, there being 9 teachers of this age. The median age is 30 years. This means that teachers of agriculture are sufficiently mature to undertake the work of training boys for the farming work.

TABLE 1

Age of teachers of agriculture

AGE IN YEARS	NUMBER OF TEACHERS
23	1
24	2
25	4
26	3
27	3
28	7
29	2
30	7
31	9
32	7
33	8
34	6
35	5
36	2
37	4
38	0
39	0
40	0
41	0
42	2
43	0
44	1
Median	30 years

EDUCATIONAL ATTAINMENT OF TEACHERS

The educational attainment of the teachers studied is shown in table 2. Of the 74 teachers, 61, or 82 per cent, are graduates of colleges of agriculture or veterinary science. The rest, except 2, have either graduated from an agricultural school or have studied in an agricultural school or in the college of agriculture.

As stated in the opening paragraph of this paper, a teacher of agriculture should be vocationally competent in farming. In table 2 it is shown that 72 of the 74 teachers possess some technical training in the field of agriculture. Only 82 per cent, however, are college graduates. Those who have not graduated from college are usually old in the service and are men with long experience in the work. A desirable teacher of vocational agriculture is, of course, one who holds at least a bachelor's degree in agriculture. Graduation from a college of agriculture is now one of the requirements for new teachers in agricultural and rural high schools in the Islands.

TABLE 2

Educational attainment of teachers

EDUCATIONAL ATTAINMENT	NUMBER OF TEACHERS
Graduates, College of Agriculture (P. I.)	51
Graduates, colleges of agriculture (U. S. A.)	4
Graduates, College of Veterinary Science (P. I.)	6
Graduates, agricultural high schools	5
Studied in agricultural high schools	2
Studied in College of Agriculture	4
Graduate, Normal School	1
High School Teacher's Certificate (U. S. A.)	1
Total	74

OCCUPATIONAL BACKGROUND

The social classes from which teachers of agriculture were drawn were also studied. As shown in table 3, 56 of the 74 teachers come from families engaged in farming. This number comprises 76 per cent of the total number of teachers included in the survey. This means that about three-fourths of the teachers of agriculture, being sons of farmers, probably possess first-hand knowledge of farm life, its problems and needs. Being sons of farmers, it is probable that they possess occupational experience in farming as a result of observation and participation.

Of the 74 teachers studied, 46, or 62 per cent, were raised in farming communities, as shown below:

Raised in fishing community	1
Raised in town	27
Raised in a farming community	46
Total	74

Although only 46 were raised on a farm, 56 were sons of farmers. This was because the parents of 10 teachers, although engaged in farming, resided in a town.

TABLE 3

Occupational background of teachers of agriculture

OCCUPATION OF FATHER	NUMBER OF TEACHERS	PERCENTAGE
Farmer	56	75.69
Merchant	6	8.11
Fisherman	2	2.70
Clerk	2	2.70
Justice of the Peace	2	2.70
Cigar maker	1	1.35
Baker	1	1.35
Musician	1	1.35
Tailor	1	1.35
Church employee	1	1.35
Dead	1	1.35
Total	74	100.00

FARM EXPERIENCE

Only 2 of the 74 teachers indicated that they had had no farm experience before they became teachers. The rest indicated possession of farm experience in varying degrees. The sons of farmers obtained certain farm experience on the home farm. In some cases this experience was limited to the managerial type. Those raised in towns and drawn from families not engaged in farming obtained the major part of their experience in the agricultural schools and college which they attended. Only a very few teachers, however, had been actual farmers or farm laborers before becoming teachers of agriculture.

As has been stated, a teacher of agriculture should possess the necessary skills and technical knowledge in agriculture. He must be familiar particularly with the principles and practices of the

type of farming found in the region where the school is located. Farm experience in coconut production is not as valuable ln a tobacco region as farm experience in tobacco production. Hence, it is important that the farm experience of a teacher should be in the type of agriculture found in the region where he is teaching.

An attempt was made to discover the proportion of teachers raised in the province where they were teaching. As shown in table 4, in 9 schools, no teacher is a native of the province where the school is located. In 4 schools, from one-fourth to one-half of the teachers come from the province where they are teaching. In only 4 of the 18 schools studied are more than half of the teachers from the province in which the school is located.

Of the 74 teachers, only 21, or 28 per cent, are teaching in the province where they were brought up. This should not mean, however, that the farm experience of the majority of teachers is not the kind demanded in their work. The type of farming in one province may be the same as that in another. Farm experience obtained on a rice farm in Bulacan is probably as valuable as the farm experience on a rice farm in Nueva Ecija for teachers of agriculture in the latter province. The two provinces have the same type of agriculture.

TABLE 4

Percentage of teachers teaching in the province

FROM SAME PROVINCE	NUMBER OF SCHOOLS
per cent	
0	9
1-25	1
26-50	4
51-67	4

PROFESSIONAL TRAINING OF TEACHERS

A good teacher of agriculture must be a good teacher besides being a good farmer. He should possess the necessary training for the job of teaching. Below is shown the professional preparation of teachers of agriculture.

Total teachers			74
Without professional preparation		60	
With training in agricultural education		2	
With training in general education		3	
With one or more educational course taken in the Department of Agricultural Education		9	
Educational Psychology	1		
Psychology, Methods	5		

Psychology, Measurement	1
Methods, Measurement	1
Psychology, Methods, Supervised Teaching	1

It will be seen that 60 of the 74 teachers, or 81 per cent, have no formal professional training of any kind for teaching. Only 5 teachers, or 6.8 per cent, have sufficient training in general or agricultural education. Nine teachers have taken one or more courses in education.

In academic high schools, formal preparation for teaching is required. Prospective teachers must have taken educational courses. In the different states in the United States, no teacher, academic or vocational, is allowed to teach in a high school without having obtained the necessary professional training. Compared with teachers in our academic high schools and with teachers in academic and agricultural schools in the United States, our teachers of agriculture are deficient on the professional side. In the past, all attention was given to technical preparation,—acquisition of subject-matter. Only recently has attention been directed to the professional training of teachers of agriculture.

CIVIL SERVICE ELIGIBILITY

The civil service eligibility of the teachers is shown in table 5. A teacher of agriculture of the secondary level should be one who has qualified as a senior teacher of agriculture. The survey shows that only 20 teachers or 27 per cent, satisfy this standard. There are, in addition, 5 teachers who have qualified as junior teachers of agriculture. Although many have taken the examination for a teacher of agriculture, they have failed to qualify partly because of their deficiency in professional preparation.

TABLE 5

Civil service eligibility of teachers

CIVIL SERVICE ELIGIBILITY OF TEACHERS	NUMBER OF TEACHERS
Senior teacher of agriculture	20
Senior teacher	1
Junior teacher of agriculture	5
Junior teacher	4
Assistant agriculturist	2
Junior agriculturist	1
Junior teacher of woodworking	1
First grade	1
None	39
Total	74

YEARS OF TEACHING EXPERIENCE

The length of teaching experience of teachers of agriculture is shown in table 6. Of the 74, only 4 do not have teaching experience of any kind. The rest have from 1 to 21 years of teaching experience. The median total teaching experience in agriculture and in other fields is 5 years.

Of the 74 teachers, 34 have taught in other fields before they became teachers of agriculture of secondary grade.

Only 7 of the 74 teachers studied have no experience in teaching agriculture. The others have teaching experience ranging from 1 to 19 years. The median teaching experience is 3 years. This is quite satisfactory when one considers the fact that the program of vocational agriculture of secondary grade has expanded only in recent years.

TABLE 6

Years of teaching experience

YEARS OF EXPERIENCE	IN VOCATIONAL AGRICULTURE	IN OTHER FIELDS	TOTAL TEACHING EXPERIENCE
0	7	40	4
1	10	7	8
2	12	11	10
3	11	4	6
4	2	3	5
5	6	4	5
6	5	0	4
7	3	1	5
8	9	2	7
9	5	1	4
10	1	0	4
11	1	1	5
12	0	0	1
13	0	0	3
14	0	0	0
15	0	0	0
16	0	0	0
17	0	0	0
18	1	0	1
19	1	0	1
20	0	0	0
21	0	0	1
Total	74	74	74
Median	3	2 [a]	5

[a] Median experience of those who have taught in other fields.

NUMBER OF SUBJECTS TAUGHT

The number of subjects taught by each teacher is shown in table 7. The number ranges from one to five subjects. Those teaching only one subject are usually principals. The majority of teachers teach two or three subjects.

The number of subjects taught by each teacher is greatly influenced by the size of the school. In large academic high schools, where there are five or more sections in the first year, a first year teacher may be assigned to teach only one subject but for five or six periods. In a large agricultural school such as Central Luzon, a teacher may teach only one subject; for example, five sections of horticulture. In the majority of agricultural schools, however, there are only a few teachers of agriculture. Since each teacher must be given a sufficient teaching load, he usually has to teach several subjects. A teacher of agriculture must be familiar, therefore, with different phases of agriculture.

TABLE 7

Number of subjects taught by each teacher

NUMBER OF SUBJECTS	NUMBER OF TEACHERS
1	14
2	26
3	19
4	11
5	4

RELATION OF TRAINING TO TEACHING WORK

In table 8 is shown the relation between the technical training of the teachers and the nature of the teaching work being done by them. It will be seen that a person who majored in a certain field of agriculture may be required to teach in other fields. The 24 teachers who majored in agronomy were teaching different agricultural and related subjects in the curriculum. They were required to teach other courses besides horticulture and farm crops. They were called upon to handle courses in animal husbandry, farm economics, and farm physics. In the same way, only 3 of the 8 persons who took their major in animal husbandry were actually teaching that subject. The others were teaching other subjects in the curriculum, some of which are closely related to animal husbandry.

The desirable arrangement is, of course, for a teacher to teach, first, his major subject, and then other related subjects. But there are factors which make this somewhat difficult. First, there is the

TABLE 8

Relation between major and subjects taught

MAJORS	TEACHERS MAJORING	SUBJECTS TAUGHT									
		Horti-culture	Farm Crops	Plant Pests	Animal Hus-bandry	Farm Science	Farm Biology	Farm Eco-nomics	Account-ing	Farm Arith-metic	Farm Physics
Agronomy	24	9	10	4	5	4	5	9	4	4	4
Animal Husbandry	8	1	1	1	3	4	4	2	2	2	—
Agricultural Chemistry	5	2	—	3	2	1	1	1	2	2	2
Plant Physiology	5	2	—	3	2	3	3	—	1	1	1
Rural Economics	3	—	2	1	—	1	1	—	1	1	2
Agricultural Engineering	2	—	—	—	—	—	—	1	1	1	2
Entomology	2	—	1	1	—	—	—	—	—	—	—
Veterinary Medicine	3	—	—	—	2	1	1	—	—	—	1

conflict in the school program. And second, the number of teachers in a school is usually limited and each teacher may be required to teach any subject. A better correlation between the major and the subjects taught may be obtained if teachers are selected according to the demands of the school. When a teacher of farm physics is needed, preference should be given to a graduate who has majored in this field,—agricultural engineering. Similarly, preference should be given to those who have majored in horticulture, farm crops, or animal husbandry, depending upon the needs of the school where they are to teach.

IMPLICATIONS OF FINDINGS ON A TEACHER TRAINING PROGRAM

Selection of students for teaching work

Because of the importance of the work of the teacher of agriculture, it is necessary that rigid selection be exercised by the teacher-training institution in selecting students for the teaching service. Among other desirable qualifications, a prospective teacher of agriculture should possess a high degree of intelligence, a wealth of farm experience, and an aptitude for teaching.

At the present time, many advanced students in the College of Agriculture apply for registration as students for the teacher training course offered in the teacher-training department (Department of Agricultural Education) of the College. Only those who rank high in intelligence, as shown by their scholastic standing, are admitted. The object of this standard is not only to limit the output to a number sufficient to meet the demands of the teaching service, but also to produce high-grade teachers of agriculture.

In the selection of students preparing for teaching, preference is given by the department to those who have had actual farm experience. Preference is given to those individuals who are sons of farmers, who were brought up in farming communities, who have actually performed a wide variety of farm operations, who have attended a school and a college of agriculture, and who have actually done independent farming while pursuing technical training in those institutions. Experience in actual farming before or after graduation from a school or college of agriculture is considered highly desirable.

Aptitude for teaching is discovered when the students take the elementary courses in agricultural education. Only those who show proper aptitude for teaching are allowed to continue in the teacher-training course.

Preparation of prospective teachers

The teacher training department is primarily concerned with the professional side of the teacher's preparation. The definite object of the work is to equip the prospective teachers with such skills, knowledges, attitudes and ideals as are required for successful teaching in the field of agriculture. Besides acquiring a knowledge of the theory and principles of teaching agriculture, prospective teachers must go through a period of practice in teaching agricultural subjects. They must possess a knowledge of the science as well as acquire the art of teaching in this particular field.

The teacher-training curriculum of the Department of Agricultural Education has been devised to meet the foregoing requirements. Since a prospective teacher may be called upon to handle different agricultural subjects, sufficient practice in the teaching of different agricultural subjects in the practice school of the department is given. Besides his major subject, practice teaching is required in several minor fields.

Although the primary responsibility of the teacher training department is to give the professional phase of the teacher's preparation, it also gives consideration to the technical preparation of prospective teachers. Agricultural teachers may be called upon to teach not one but several subjects. A student who majored in horticulture may be called upon to teach animal husbandry, plant pests and other subjects. A student who majored in animal husbandry may be called upon to teach farm crops. Too much specialization in one phase of agriculture may not prepare the prospective teachers to meet the present requirements of the agricultural teaching service. Hence, the department requires that a prospective teacher also possesses adequate knowledge and practical experience in other branches of agriculture besides his major. Whenever it is found that a prospective teacher is deficient in the science and practice of certain phases of agriculture, the teacher training department requires that such deficiency be corrected before he is allowed to complete the teacher training course.

Training of teachers in service

Even if teachers of agriculture meet the technical and professional qualifications when they enter upon the work of teaching, further training in service is required. There are problems which have not been touched upon during the short period of preparation. There are problems which are peculiar to certain regions or schools. Furthermore, training in service is necessary in order that teachers

of agriculture may keep up with the development in the field of agriculture and in the field of general and agricultural education.

The training of teachers in service becomes increasingly important when teachers have deficiencies in their technical and professional preparation, as is the case with many teachers of agriculture in the Philippines. The great majority of agricultural teachers are deficient in professional training. Undergraduates of agricultural colleges need further training in agriculture.

Forms of improvement of teachers in service

The improvement of teachers is accomplished in various ways. There are supervisors of agriculture who give assistance to teachers in the field. Individual assistance is also given to teachers by itinerant teacher trainers, as is found in some states in the United States. Aside from administrative duties, the principal of an agricultural school performs supervisory work over his teachers. This is especially true in the Philippines where supervisory personnel is limited in number. Improvement of teaching may be obtained through conferences and teachers' meetings. Saturday classes among teachers may be held in each school under the supervision of the principal. Professional improvement is also attained by reading of books, bulletins and journals containing results of researches and investigations. One common way in which teachers may improve professionally is by attending a summer school.

The teacher-training department of the College of Agriculture contributes to the professional improvement of teachers through summer courses. When supervisory personnel is limited in number, attending summer school is probably the least expensive means of professional improvement for teachers. The employment of itinerant teacher trainers has been tried in many states but found expensive for two reasons. One is the expense of going from one school to another. Another is, that it is a form of individual instruction. When much of supervision is left to the principal of the school, it is important that the principal possesses a good preparation in general education as well as in vocational education in agriculture. When he is deficient in these, he should also improve his qualification through summer school attendance. Successful demonstrations, conferences, teachers' meetings and Saturday classes also demand a principal who is well equipped along technical and professional lines. Regional and national conferences among teachers may result in improvement of teaching. National conferences, however, are usually of short duration. Hence only a few problems, usually general in nature, are taken up. For teachers of agriculture without pre-

vious formal training for teaching, the summer course is one of the most feasible methods of improvement in service. Summer courses have been found to be one of the most effective means of professional improvement among elementary school teachers who are deficient in professional preparation.

Summer courses offered by the teacher-training department of the College of Agriculture are designed to meet the needs of two groups, the principal and the teacher. The principal performs not only teaching but also administrative and supervisory duties. He should have a thorough understanding of his duties and the necessary perparation to execute them efficiently. The teachers, on the other hand, must be trained to perform efficient instruction in the classroom and in the field.

SUMMARY

1. The median age of teachers of agriculture was 30 years.

2. Seventy-two of the 74 teachers possessed technical training in agriculture, but only 61, or 82 per cent, were college graduates.

3. Seventy-six per cent of the teachers came from families engaged in farming.

4. Seventy-two of the 74 teachers had acquired certain amount of farm experience before they became teachers. Farm experience was largely acquired from the home farm or from the school attended, or both.

5. Twenty-eight per cent of the teachers were teaching in their native province.

6. Eighty-one per cent of the teachers had no formal professional training of any kind for teaching. Only 5 teachers, or 6.8 per cent, possessed sufficient training in general or agricultural education.

7. Twenty-seven per cent of the teachers had qualified as teachers of agriculture.

8. The median teaching experience in agriculture of the teachers studied was three years.

9. The majority of teachers were teaching from two to three subjects. Hence teachers of agriculture are being prepared by the teacher training department of the College of Agriculture to handle not only a major, but also several minor subjects.

10. Professional improvement is greatly needed by teachers of agriculture. One of the best means of training teachers in service is the summer school. Hence the teacher-training department in the College of Agriculture offers appropriate summer courses for teachers desiring to become better qualified.

BLIGHT OF CINCHONA SEEDLINGS [1]

M. S. Celino
Of the Department of Plant Pathology

WITH ONE PLATE AND SIX TEXT FIGURES

The outbreak of a serious seedling blight of *Cinchona* (quinine) in the nursery of the Department of Agronomy, College of Agriculture at Los Baños was first reported to the Department of Plant Pathology on February 19, 1932. The quinine seedlings representing the species *Cinchona calisaya* var. *ledgeriana*, *C. hybrida*, and *C. succirubra* were severely infected. These seedlings were said to have come from the Bureau of Forestry and they were still in the boxes in which they were shipped to the College of Agriculture (fig. 1).

Fig. 1.—*Cinchona* seedlings in the box in which they were shipped from Bukidnon to the College of Agriculture. Note the seedlings on the right dead and dying owing to the attack of the disease.

After a survey of the disease situation was made, all of the dead and dying infected seedlings were immediately removed and the remaining plants were sprayed with standard Bordeaux mixture of the formula 4-4-50 in order to protect them from the blight infection. The severity of the disease may be seen in table 1 which gives the number of seedlings in each box, the number of seedlings not infected by

[1] Experiment Station contribution No. 959. Prepared in the Department of Plant Pathology under the direction of Dr. G. O. Ocfemia.
Read before the Los Baños Biological Club August 24, 1933. Received for publication September 9, 1933.

the blight and the number of plants attacked. Of the seedlings infected some were dead and others were so severely infected that it was hopeless to save them. The seedlings noted in the sixth column under heading "Number of diseased seedlings per box" were removed and destroyed by burning.

On January 30, 1933 the seedling blight of *Cinchona* broke out again in the *Cinchona* cultures of the Department of Plant Pathology. This time on seedlings grown from seeds obtained from Professor Alejandro de Mesa of the School of Forestry. Counts of the seedlings showed that from January 30 to July 3, 1933 twenty-five of the 55 quinine seedlings or 45.45 per cent became infected with the disease. Most of the seedlings became diseased in the latter part of June and early part of July.

Isolations made from the blighted seedlings on February 2 and 9, 1933 yielded a fungus belonging to the genus *Phytophthora*. The present paper gives an account of this fungus which the writer has proved experimentally to cause blight of *Cinchona* seedlings.

THE DISEASE

History and distribution

The *Phytophthora* blight of *Cinchona* seedling has not hitherto been reported in the Philippines. This is because *Cinchona* is of recent introduction into these Islands. The damping-off of seedlings and stem canker of *Cinchona* were recently reported in an unpublished manuscript of Mr. Gil M. Altamirano, a ranger of the Bureau of Forestry, as being prevalent in the Cinchona Experiment Station of the Bureau of Forestry in Bukidnon, Mindanao. The causal parasites of these diseases were not, however, determined.

According to Dr. N. B. Mendiola, Head of the Department of Agronomy, the *Cinchona* seedlings in culture at the College of Agriculture in 1927 all died of a disease, the symptoms of which were very similar to those of the *Cinchona* blight described in this paper. It would seem that the disease is an important factor in the growing of *Cinchona* in the Philippines.

McRae (1930) reports a seedling disease of *Cinchona* in Mungpoo, India; from it he isolated a *Phytophthora*. *Cinchona* seedlings which were inoculated with cultures of *Phytophthora* at Munsong and Pusa where the temperature was 22 and 27°C., became readily infected and many died. Seedling plants which were inoculated at Sureil where the temperature was 20°C. did not get the disease.

Symptoms

The tips of the young and tender shoots of *Cinchona* seedlings suddenly die and dry out without marked preliminary changes. From the blighted tips the infection progresses down and causes the gradual drying of the stem and the petioles of the leaves. The infection of the petioles is followed by the death of the leaves. The dead dried leaves usually persist on the plant hanging downwards. The infection progresses rapidly in young seedlings and if allowed to continue unchecked the infected plants die in five to six days under moist conditions.

In some cases the blighting of the plant starts from the tips and occasionally from the margin of the leaves. These regions are at first discolored, then they become dark brown and die. The discoloration and dying out of the leaves work from the tips and margins to the center and petioles of the leaves until the entire leaves are diseased. The infection from the petioles easily reaches the stem and the entire plant becomes involved.

CAUSAL ORGANISM

Method of isolation

The causal fungus was isolated from a leaf of *Cinchona* which had the incipient stage of infection. Sixteen small sections (5 mm. sq.) from the border of infection in the leaf were immersed in a solution of mercuric bichoride (1:1000) from 30 seconds to one minute. With the aid of a flamed wire loop the leaf sections were transferred from the disinfectant to a series of three test tubes of sterile water. The leaf sections were then planted on solidified sterile potato dextrose agar in four petri dishes, four sections to every dish. From the isolated colonies of *Phytophthora* which appeared after 72 hours, subcultures were made to sterile slant potato dextrose agar in test tubes. These subcultures of *Phytophthora* in the test tubes were found afterwards to be pure.

Morphology

Mycelium. Like other members of the genus *Phytophthora* the species isolated from *Cinchona* produces distinct submerged and aërial hyphae. Young mycelium is usually coarse, densely granular, nonseptate and branched. Old hyphae are less densely granular, vacuolate or partly empty. Submerged mycelium is usually coarser, wider and much more irregular and branched than the aërial hyphae.

Measurements of the diameter of 50 submerged hyphal threads vary from 3 to 10.5μ with an average of 6.65μ. Aërial hyphae measure from 3 to 9μ in width with an average of 5.47μ.

Conidiophores. The conidiophores are much like the aërial mycelium although generally narrower than it. The measurements of 50 conidiophores varied in width from 2.5 to 6.3μ with an average of 3.58μ.

Conidia. The conidia are variable in shape from almost spherical, oval, to elongate (pl. 1, fig. 1). They are hyaline to light yellow, densely granular, with or without vacuoles, apically papillate and are produced on the conidiophore either terminally or laterally. With age the spores become vacuolate or sometimes the cytoplasmic contents shrink and gather in the center. The size of the conidia varies greatly as may be seen in table 2.

Table 2 shows the measurements of the lengths and widths of 400 conidia of the *Cinchona* blight *Phytophthora* arranged in classes made by a difference of 2 microns. The data show that the lengths of the 400 conidia fall between class 19.5–21.49μ and class 95.5–97.49μ, the average length being 48.63μ. The widths fall between class 15.5–17.49μ and class 49.5–51.49μ with an average width of 32.06μ. Comparing these figures for the length and width of the conidia of the *Cinchona* blight *Phytophthora* with those of the *Phytophthora faberi* as given by various authors and which are shown in table 3 it will be seen that the figures are almost identical.

It may also be seen in table 3 and also in table 1 that in the *Cinchona* blight *Phytophthora* the lengths of the majority of the conidia are between class 33.5–35.49μ and class 61.5–63.49μ. The widths are between class 19.5–21.49μ and class 41.5–43.49μ. These figures are again almost the same as those for *P. faberi* as reported by various investigators. In table 3, last column, it may also be seen that the greatest number of conidia are in the classes 33.5–35.49μ and 27.5–29.49μ. Of these figures the class 33.5–35.49μ seems to differ considerably from the classes 49.5–51.49μ, 55.5–57.49μ and 43.5–45.49μ wherein the greatest number of conidia of *P. faberi* fall. However, in table 1 it may be seen that in the *Cinchona* blight *Phytophthora* the class 33.5–35.49μ has 40 conidia. The next greatest number of conidia which is 37 falls in the class 45.5–47.49μ. This class (45.5–47.49) is very close to the classes 49.5–51.49μ and 43.5–45.49μ for *P. faberi*. The difference of 3 conidia of the classes 33.5–35.49μ and 45.5–47.49μ is not significant, evidently the presence

of 40 conidia in the former does not offer sufficient evidence for the establishment of another species. The lengths and widths of 400 conidia are shown graphically in figures 2 and 3.

Ratio of length of conidia to width. The ratios of length of conidia to width are shown in table 4. From this table it may be seen that the ratio of length of the conidia to width falls between the classes 1.05–1.14μ and 2.25–2.34μ, the majority of the conidia have the ratio of the length to width from class 1.15–1.24μ to class 1.75–1.84μ, and the greatest number of conidia have the ratio of length to width in class 1.35–1.44μ. The average ratio of length to width is 1.44μ. According to Reinking (1923) the ratio of the length of the conidia to the width in the *P. faberi* falls from the class 1.05–1.14μ to class 3.45–3.54μ for the coconut strain and from the class 1.05–1.14μ to the class 2.95–3.04μ for the cacao strain, with an average ratio for both strains of 1.68μ. Rosenbaum (1917) found

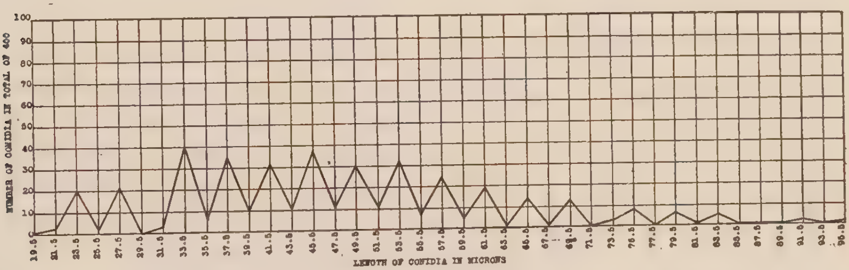


Fig. 2.—Graph showing the variation in length of the conidia of the fungus *Phytophthora*, isolated from *Cinchona*.

the ratio of the length of the conidia to width in *P. faberi* from the class 0.95–1.04μ to the class 2.35–2.44μ with a mean ratio of 1.47μ. The ratio of length to width of the greatest number of conidia is in the class 1.35–1.44μ. For the same fungus isolated from citrus Ocfemia and Roldan (1927) reported the ratio of length of conidia to width from class 0.95–1.04μ to class 2.15–2.24μ, the greatest number of the conidia having the ratio in class 1.45–1.54μ. From these data it is evident that the writer's figures for the ratio of the length of the conidia to width for the *Cinchona* blight fungus and those of the various authors for *P. faberi* are very much the same. Text figure 4 shows the ratio of the length of the conidia to width in graphic form.

Chlamydospores. The chlamydospores are spherical, smooth, granular like the conidia but usually with slightly deeper color (pl. 1, fig. 2). They appear in culture much earlier than the conidia

and are developed in the mycelium, either terminally or intercalary. The diameter varies greatly. The measurements of 400 chlamydospores are shown in table 2, arranged in classes made by a difference of 2 microns. It may be seen from this table that the chlamydospores have diameters in classes from 17.5–19.49μ to 61.5–63.49μ. The majority of the spores have diameters in classes from 19.5–21.49μ to 49.5–51.49μ, while the greatest number of them have diameters in class 27.5–29.49μ. The average diameter is 35.89μ. Text figure 5 shows graphically the diameters of 400 chlamydospores.

Reinking (1923) found the diameters of the chlamydospores of *P. faberi* coconut strain to vary from 19.5 to 61.49μ. The diameters

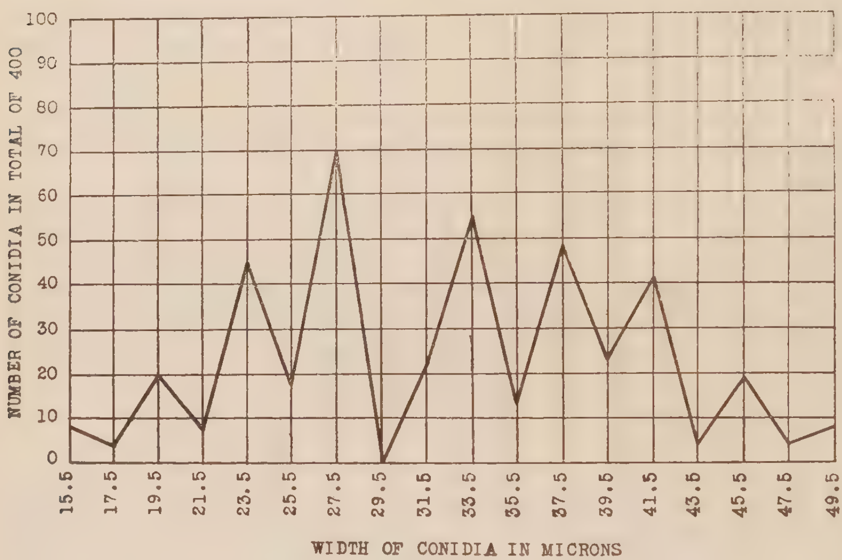


Fig. 3.—Graph showing the variation in width of the conidia of the fungus *Phytophthora*, isolated from *Cinchona*.

of the greatest number fall from 43.5 to 45.49μ with an average of 41.62μ. The diameters of the cacao strain of *P. faberi* range from 17.5 to 53.49μ, the majority of the chlamydospores have diameters from 35.5 to 47.49μ and the greatest number have diameters in class 43.5–45.49μ. The average diameter is 41.06μ. Rosenbaum (1917) reports the diameters of the chlamydospores of *P. faberi* from 27.5 to 59.49μ. The majority of the chlamydospores have diameters from 29.5 to 49.49μ, the greatest number of them have diameters in class 37.5–39.49μ. Ocfemia and Roldan (1927) report for *P. faberi*, citrus strain, diameters ranging from class 19.5–21.49μ to class 47.5–49.49μ.

The majority of the chlamydospores have diameters which fall from class 21.5–23.49 to class 43.5–45.49μ. The greatest number of chlamydospores have diameters in the class 35.5–37.49μ. The average diameter of 400 chlamydospores is 31.01μ. It appears that these data for the chlamydospores of *P. faberi* by different authors and those of writer's for the *Cinchona* blight *Phytophthora* are very close, the average diameter is especially very close to that given by Ocfemia and Roldan for the *P. faberi*, citrus strain.

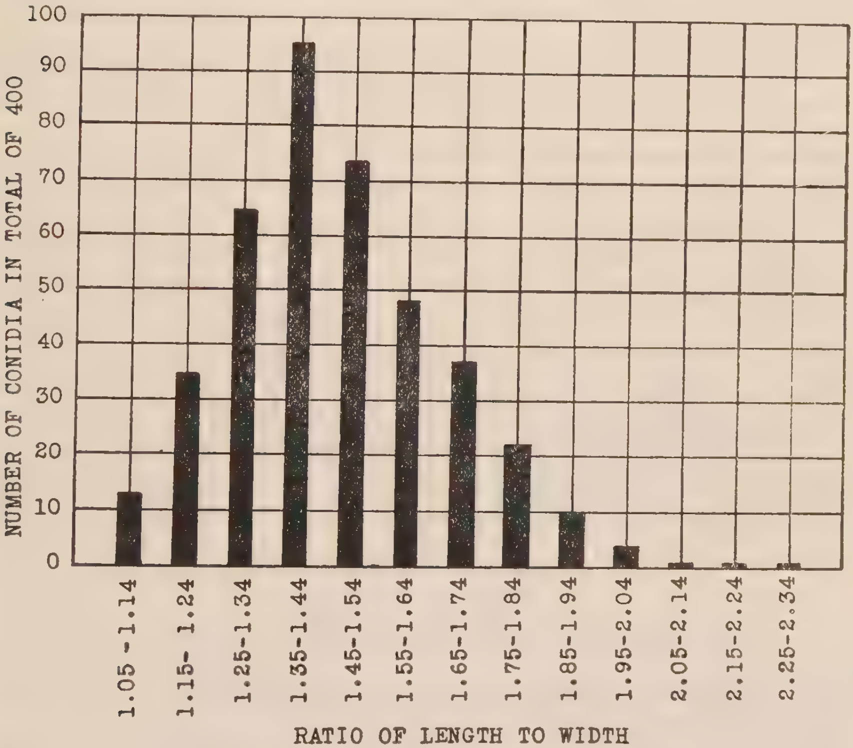


Fig. 4.—Arrangements in classes of the ratios of length to width of the conidia of the fungus *Phytophthora*, *Cinchona* strain, showing the limits of variation.

Germination of conidia and chlamydospores

The conidia and chlamydospores germinate readily by the production of one to several germ tubes (pl. 1, fig. 3). Occasionally a conidium germinates indirectly, that is, by the production of zoöspores (pl. 1, fig. 4). The zoöspores are extruded through the papillum and germinate directly afterwards. In this work the conidia of the fungus had been induced to germinate indirectly in the

presence of an abundance of water in the medium and at a temperature of 15°C. for 20 to 25 minutes. The protoplasmic contents of the conidium divide into several fragments and each fragment rounds up into a definite body or zoöspore. In a short time after the formation of the zoöspores the conidium opens at the papillum and the mass of zoöspores goes out in less than a minute. The zoöspores become at once actively motile for about 30 minutes. Then they settle down and after 10–20 minutes they start to germinate by producing germ tubes. One to two germ tubes develop from a zoöspore (pl. 1, fig. 5).

The zoöspores are slightly elongate and pointed when actively moving but are generally spherical after they have settled down.

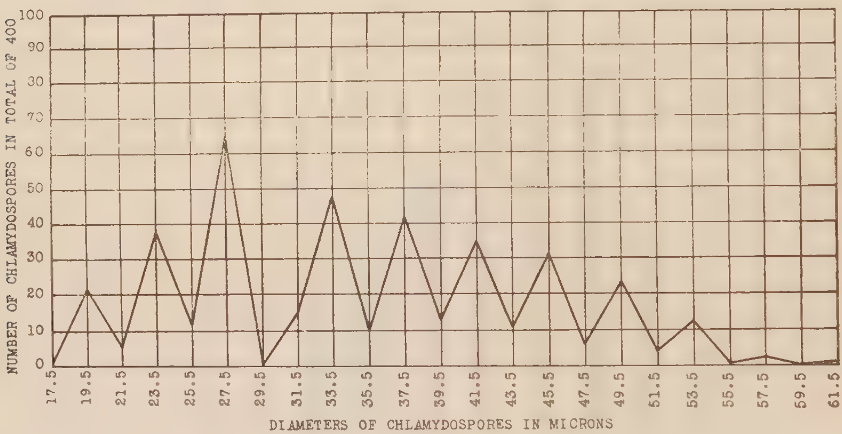


Fig. 5.—Graph showing the variation in diameters of the chlamydospores of the fungus *Phytophthora,* isolated from *Cinchona.*

They are slightly greenish in color, granular with or without vacuole and no distinct cell wall.

The zoöspores were measured immediately after they had settled down and it was found that among the fifty zoöspores measured the diameter ranged from 8.4 to 12.6μ with an average of 10.75μ.

Cultural studies

The behavior of the fungus on various culture media are given below.

Oatmeal agar. The fungous growth was at first submerged. Three to four days later, white cottony aërial hyphae began to appear on the surface. After 10 days the surface of the slant was practically covered with aërial growths which were thicker at the base

of the agar. Chlamydospores appeared much earlier than the conidia and much more abundant.

Potato dextrose agar. The mycelium was at first submerged, later aërial mycelium appeared profusely, chlamydospores were produced abundantly and they appeared 3 to 4 days earlier than the conidia.

Steamed corn meal. The fungous growth was moderate. Thin aërial hyphae covered the surface of the medium. Spores appeared on the fifth day and were fairly abundant after two weeks.

Corn meal agar. The growth of the mycelium was slow, at first submerged, later aërial. The fungous mycelium was thick at the base of the agar. Spores fairly abundant after two weeks.

Water agar. The growth of the mycelium was very poor. Few hyphal branches were noticeable on the surface of the agar. Very few conidia and chlamydospores appeared in six weeks old culture.

Glycerine agar. The fungus was grown on 3, 4 and 5 per cent glycerine agar preparations. The fungous growth in these media was almost as poor as in water agar. Very few conidia and chlamydospores were seen in cultures six weeks old.

As described above, the best media found for the *Cinchona* blight fungus were oatmeal agar, potato dextrose agar, steamed corn meal and corn meal agar. In these media the fungous mycelium developed profusely and conidia and chlamydospores appeared abundantly in cultures one to two weeks old. The chlamydospores always appeared earlier than the conidia and even in old cultures they were much more numerous. No oöspores were found.

Proof of pathogenicity

On February 10, 1933 two healthy *Cinchona* seedlings, one year old and about 12 to 15 cm. tall, of the species *Cinchona hybrida* and *Cinchona calisaya* var. *ledgeriana* were inoculated with the pure culture of *Phytophthora.* The fungus was applied on the uninjured young shoots and at the petioles of the leaves. The control plants were treated similarly except that sterile potato dextrose agar was applied to them. Both the inoculated and control seedlings were kept in the damp chamber for two days, then they were transferred to the shade outside of the laboratory.

Twenty-four hours after inoculation slight infection began to appear in the inoculated seedlings. The young shoots and the petioles became slightly discolored and showed signs of rotting. On the second day after inoculation the blighting of the shoots and the leaves was very well advanced. The infected shoots were wilted,

dark brown, distorted and the top leaves lost their turgidity and began to hang downward and were slightly wilted. The condition of the plants can be clearly seen in text figure 6. The photograph for this figure was taken on February 15, five days after the plants were inoculated.

On February 16 the fungus was reisolated following the tissue culture method and on February 20 pure culture of the fungus was obtained.

On the same date two healthy *Cinchona* seedlings were inoculated with this new culture of the fungus following the method already explained. Three days after inoculation the treated plant showed typical blighting of the shoots and the leaves. The control plants remained healthy.

On February 24 four *Cinchona* seedlings were inoculated under shade outside of the laboratory. After inoculation the plants were

Fig. 6.—*Cinchona* seedlings one year old. The seedlings on the right were inoculated with pure culture of the fungus *Phytophthora*. Note the blighted shoots. Compare with the healthy seedling on the left.

watered slightly to moisten the leaves and afterwards daily three times a day for three successive days.

On the eighth day after inoculation symptoms of blight infection began to appear. The shoots and the petioles became dark brown, water-soaked and after three more days typical blight was well established.

The experiments described above proved conclusively the pathogenicity of the fungus.

TAXONOMY

The average size of the conidia of the Philippine *Phytophthora Cinchona* strain is $48.63 \times 32.06\mu$. This figure is very close to $52.27 \times 31.28\mu$ and $51.92 \times 30.67\mu$, which is the average size of the conidia of *P. faberi* of the coconut and cacao strains and to

$44.71 \times 29.45\mu$ of the citrus strain. The range of the distribution of the length and width of the conidia, $19.5–97.49 \times 15.5–51.49\mu$ is closer to those reported by Reinking (1923) for *P. faberi* than to those given by Rosenbaum (1917) and Ocfemia and Roldan (1927) for the same fungus (table 3). The class $33.5–55.49\mu$ where the greatest number of the conidia of the *Cinchona* strain fall, although lower than the figures for the *P. faberi,* the variation is not sufficient to justify the segregation of a new species for the *Cinchona* strain. The ratio of the length of the conidia to width and the average or mean ratio are lower than those given by Reinking but nearly identical with the figures given by Rosenbaum and Ocfemia and Roldan for *P. faberi.* The average size of the chlamydospores, 35.89μ, is within the limits of variation, lower than Reinking's figure but higher than that of Ocfemia and Roldan for *P. faberi.* In culture the Philippine *Cinchona Phytophthora* behaves much like the *P. faberi* as regards rate of growth of the mycelium and production of spores.

The writer did not secure for comparison data for the *Phytophthora* isolated from *Cinchona* seedlings in India. McRae (1932), however, states in his report that the fungus does not produce oöspore in culture. This is also true with the *Cinchona* strain in the Philippines. According to Rosenbaum's tentative table for the separation of the species of the genus *Phytophthora* the absence of the oöspore places the fungus in the Faberi Group. The Philippine *Phytophthora Cinchona* strain therefore falls under this category. Tucker (1933) reports that McRae's descriptions of the fungus cultivated from *Cinchona ledgeriana* in India are similar to those of *P. palmivora* (?). The same author in 1931 concludes that *P. palmivora* Butler and *P. faberi* Maubl., are synonymous species. Following the conclusion reached by Tucker the Philippine *Cinchona* blight fungus, which according to the foregoing descriptions is similar to *P. faberi,* is synonymous to *P. palmivora* Butler.

In the present paper the writer considers the *Phytophthora* isolated from *Cinchona* the same as *P. faberi* which is the cause of the coconut bud rot, black rot of cacao pods, citrus blight, fruit rot and root rot of papaya in the Philippines.

CONTROL MEASURES

When the disease was first noted in the cultures of the Department of Plant Pathology on January 30, 1933 only two seedlings were infected. After isolating the fungus in pure culture the infected shoots were removed by cutting the stem one to two centimeters below the margin of infection. The cut stem was treated with

Bordeaux paste. The treated plants developed lateral shoots without blight and from all indications the plant will continue to grow normally.

In the latter part of June and early part of July many of the seedlings showed blight infection. All the infected shoots and leaves were removed, collected and burned to eliminate sources of inocula for future infection. The plants were then sprayed with standard Bordeaux mixture, first on July 7 and then on July 22. The disease was completely checked after the second spraying.

The Bordeaux paste and the standard Bordeaux mixture were prepared according to the method followed in the Department of Plant Pathology.

Bordeaux paste

Copper sulfate or blue vitriol	0.5 kilogram
Stone lime or quick lime	1.0 kilogram
Water	5.8 liters

The lime was slaked and then water was added to a volume of 2.5 liters. The copper sulfate was dissolved in water and the volume was made 3.3 liters. The two solutions were then mixed thoroughly by stirring the mixture vigorously. The paste was applied with a brush.

Standard Bordeaux mixture

Copper sulfate or blue vitriol	90 grams
Stone lime or quick lime	90 grams
Water	9.5 liters

The copper sulfate was dissolved in water and the volume made 4750 cc. The stone lime was slaked in water and the volume made 4750 cc. The two solutions were mixed thoroughly by stirring the mixture vigorously with a stick. The solution was then strained through a piece of cheese cloth and was finally put into the sprayer. A portable and automatic compressed air sprayer was used for spraying the plants.

SUMMARY

1. The outbreak of a serious blight of *Cinchona* seedlings in the College of Agriculture was noted on February 19, 1932 and on January 30, 1933. The disease was responsible for the death of many *Cinchona* seedlings in the cultures of the departments of Agronomy and Plant Pathology.

2. The most important symptom of the disease is the sudden drying out of the tender shoots involving the growing point of the

seedlings and finally the petioles of the top leaves. The leaves die and the dead dried leaves remain persistent on the stem hanging downwards.

3. The cause of the disease was determined as *Phytophthora faberi* Maubl., the same fungus that causes bud rot of coconut, black rot of cacao pods, stem canker of cacao, citrus blight, fruit rot and root rot of papaya in the Philippines.

4. The disease was controlled easily by removing and burning the diseased portions of the seedlings and then spraying the plants with standard Bordeaux mixture two times with an interval of two weeks.

LITERATURE CITED

M'CRAE, W. 1930. Reports of the Imperial Mycologist. Sci. Repts. Agric. Res. Inst. Pusa. **1928-29**: 56–56.

MCRAE, W. 1932. Report of the Imperial Mycologist. Sci. Repts. Agric. Res. Inst. Pusa. **1930-31**: 73–86.

OCFEMIA, G. O., AND E. F. ROLDAN. 1927. Phytophthora blight of citrus. Amer. Jour. Bot. **14**: 1–15. *Pl. 1–2; fig. 1–4.*

REINKING, O. A. 1923. Comparative study of *Phytophthora faberi* on coconut and cacao in the Philippine Islands. Jour. Agric. Res. **25**: 267–284. *Pl. 1–12; fig. 1–5.*

TUCKER, C. M. 1931. Taxonomy of the genus *Phytophthora* de Bary. Missouri Agric. Exper. Sta. Res. Bull. 153: 1–208. *Fig. 1–30.*

TUCKER, C. M. 1933. The distribution of the genus *Phytophthora*. Missouri Agric. Exper. Sta. Res. Bull. 184: 1–80.

TABLE 1

Percentage of infection of Cinchona plants by seedling blight taken on February 26, 1933 [a]

NO. OF BOXES	BUREAU OF FORESTRY ACCESSION NO.	SPECIES OF CINCHONA	NUMBER OF SEEDLINGS			PERCENTAGE OF INFECTION
			Per box	Healthy	Diseased	
1	270	*C. calisaya* var. *ledgeriana*	20	9	11	55.0
2	"	" " "	20	15	5	25.0
3	"	" " "	20	17	3	15.0
4	"	" " "	20	19	1	5.0
5	"	" " "	20	15	5	25.0
6	"	" " "	20	18	2	10.0
7	"	" " "	20	18	2	10.0
8	"	" " "	20	17	3	15.0
9	"	" " "	20	14	6	30.0
10	"	" " "	20	15	5	25.0
11	265	*C. hybrida*	20	19	1	5.0
12	"	" "	20	16	4	20.0
13	"	" "	20	18	2	10.0
14	"	" "	20	14	6	30.0
15	314	*C. succirubra*	20	17	3	15.0
16	"	" "	20	16	4	20.0
17	"	" "	20	16	4	20.0
18	"	" "	20	15	5	25.0
19	"	" "	20	18	2	10.0
20	291	" "	40	37	3	7.5
21	"	" "	40	40	0	none
22	"	" "	40	39	1	2.5
		Total	500	422	78	Av. 17.27

[a] Data secured by Mrs. Victoria Mendiola-Ela of the Department of Plant Pathology, College of Agriculture, Los Baños, Laguna.

TABLE 2

Distribution of the lengths and widths of 400 conidia and diameters of 400 chlamydospores of the Philippine Cinchona blight Phytophthora arranged in classes made by a difference of 2 microns

LENGTH CLASSES IN MICRONS	CONIDIA IN 400	WIDTH CLASSES IN MICRONS	CONIDIA IN 400	DIAMETER CLASSES IN MICRONS	CHLAMYDOSPORES IN 400
—	—	15.5–17.49	8	—	—
—	—	17.5–19.49	4	17.5–19.49	1
19.5–21.49	1	19.5–21.49	20	19.5–21.49	22
21.5–23.49	3	21.5–23.49	8	21.5–23.49	6
23.5–25.49	10	23.5–25.49	45	23.5–25.49	38
25.5–27.49	3	25.5–27.49	18	25.5–27.49	12
27.5–29.49	16	27.5–29.49	70	27.5–29.49	65
29.5–31.49	—	29.5–31.49	—	29.5–31.49	—
31.5–33.49	3	31.5–33.49	22	31.5–33.49	15
33.5–35.49	40	33.5–35.49	55	33.5–35.49	48
35.5–37.49	6	35.5–37.49	13	35.5–37.49	10
37.5–39.49	35	37.5–39.49	48	37.5–39.49	42
39.5–41.49	10	39.5–41.49	13	39.5–41.49	14
41.5–43.49	31	41.5–43.49	41	41.5–43.49	35
43.5–45.49	11	43.5–45.49	4	43.5–45.49	11
45.5–47.49	37	45.5–47.49	19	45.5–47.49	32
47.5–49.49	11	47.5–49.49	4	47.5–49.49	6
49.5–51.49	30	49.5–51.49	8	49.5–51.49	23
51.5–53.49	11	—	—	51.5–53.49	4
53.5–55.49	32	—	—	53.5–55.49	12
55.5–57.49	7	—	—	55.5–57.49	1
57.5–59.49	24	—	—	57.5–59.49	2
59.5–61.49	5	—	—	59.5–61.49	—
61.5–63.49	19	—	—	61.5–63.49	1
63.5–65.49	1	—	—	—	—
65.5–67.49	14	—	—	—	—
67.5–69.49	1	—	—	—	—
69.5–71.49	13	—	—	—	—
71.5–73.49	—	—	—	—	—
73.5–75.49	3	—	—	—	—
75.5–77.49	8	—	—	—	—
77.5–79.49	—	—	—	—	—
79.5–81.49	6	—	—	—	—
81.5–83.49	1	—	—	—	—
83.5–85.49	5	—	—	—	—
85.5–87.49	—	—	—	—	—
87.5–89.49	—	—	—	—	—
89.5–91.49	—	—	—	—	—
91.5–93.49	2	—	—	—	—
93.5–95.49	—	—	—	—	—
95.5–97.49	1	—	—	—	—

TABLE 3

Comparative sizes of the conidia of Phytophthora faberi as reported by various investigators

INVESTIGATOR	PHYTOPHTHORA	RANGE OF DISTRIBUTION OF LENGTH AND WIDTH IN MICRONS	RANGE OF DISTRIBUTION OF LENGTH AND WIDTH OF MAJORITY OF CONIDIA IN MICRONS	AVERAGE SIZE OF CONIDIA IN MICRONS	CLASS IN MICRONS IN WHICH THE GREATEST NUMBER OF CONIDIA FALL
Reinking	*P. faberi* Coconut strain	19.5–83.49 × 13.5–45.49	37.5–63.49 × 19.5–39.49	52.27 × 31.28	49.5–51.49 × 31.5–33.49
Reinking	*P. faberi* Cacao strain	19.5–89.49 × 11.5–41.49	37.5–63.49 × 19.5–39.49	51.92 × 30.67	49.5–51.49 and 55.5–57.49 × 31.5–33.49
Rosenbaum [a]	*P. faberi*	3.5–67.49 × 17.5–49.49	37.5–59.49 × 25.5–43.49		49.5–51.49 × 29.5–31.49
Ocfemia and Roldan	*P. faberi* Citrus strain	23.5–65.49 × 15.5–39.49	33.5–57.49 × 19.5–35.49	44.71 × 29.45	43.5–45.49 × 27.5–29.49
The writer	Cinchona blight Phytophthora	19.5–97.49 × 15.5–51.49	33.5–63.49 × 19.5–43.49	48.63 × 32.06	33.5–35.49 × 27.5–29.49

[a] The figures given are from the summary of sets A and B (Rosenbaum, 1917, p. 248).

TABLE 4

Ratios of length to width of 400 conidia of the Philippine Cinchona Phytophthora distributd in classes made by a difference of 0.09μ

RATIO CLASSES IN MICRONS	CONIDIA IN 400
1.05–1.14	13
1.15–1.24	35
1.25–1.34	65
1.35–1.44	95
1.45–1.54	73
1.55–1.64	48
1.65–1.74	37
1.75–1.84	22
1.85–1.94	10
1.95–2.04	4
2.05–2.14	1
2.15–2.24	1
2.25–2.34	1

[Philippine Agriculturist, Vol. XXIII, No. 2

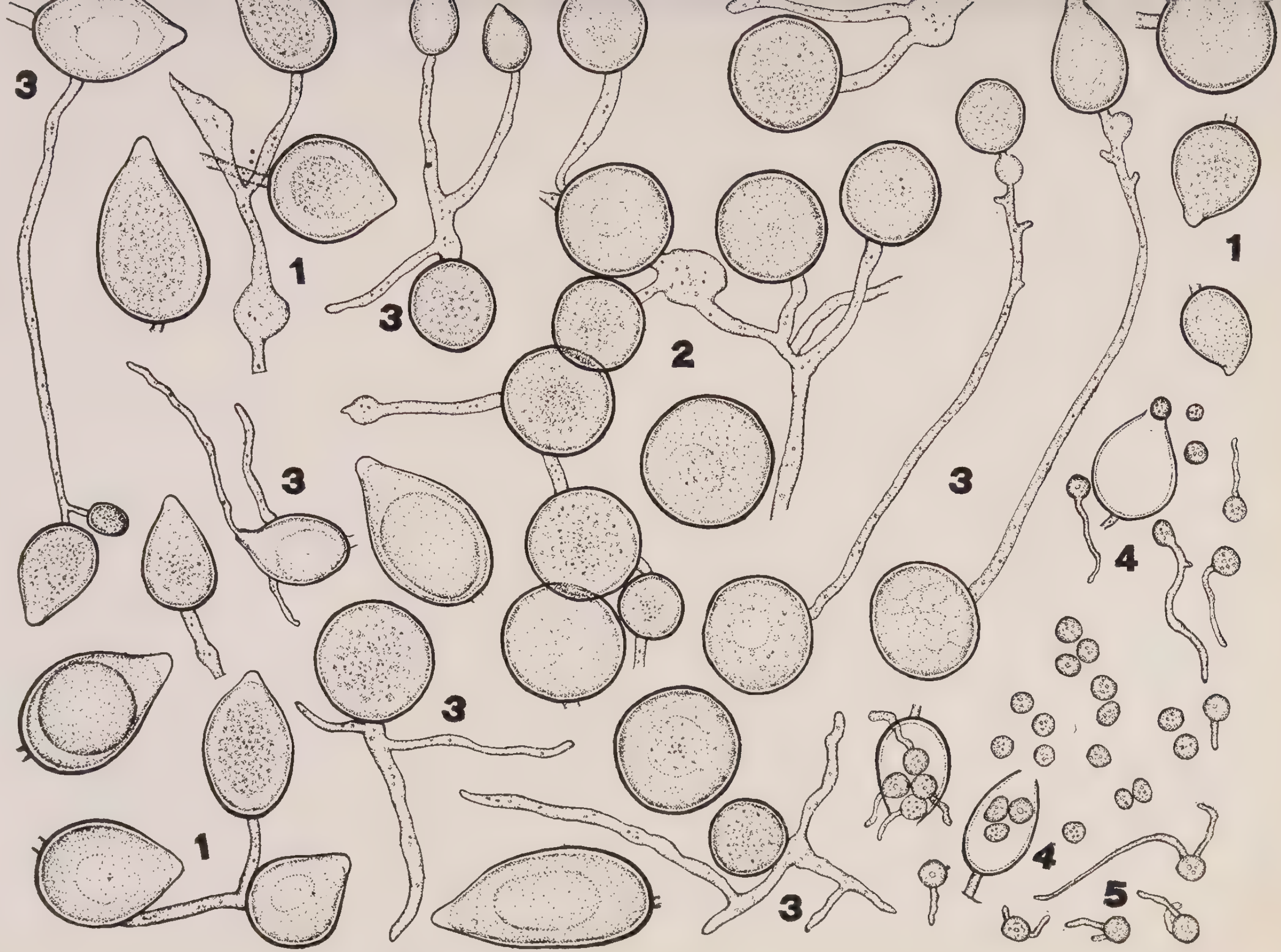


PLATE I

The fungus *Phytophthora* isolated from *Cinchona*. 1. Conidia. 2. Chlamydospores. 3. Germinating conidia and chlamydospores. 4. Conidia that produced zoöspores. 5. Germinating zoöspores producing more than one germ tubes. All drawings were made with the aid of a camera lucida. About 490 ×.

PROPAGATION OF KAPOK BY BUDDING AND GRAFTING [1]

TORIBIO MERCADO
Of the Department of Agronomy

WITH THREE TEXT FIGURES

The kapok plant which is known botanically as *Ceiba pentandra* (L.) Gaertin, is grown for its fiber. In the Philippines, kapok culture is only a minor industry, but as kapok fiber is gradually replacing other materials for stuffing mattresses, cushions, life-saving appliances, etc. the demand will increase and the Philippine kapok industry become more important.

Kapok is a perennial plant and is propagated either by seed or by cuttings. But these methods of propagation offer some serious disadvantages, especially to those who desire to grow this crop on a commercial scale. Kapok plants propagated by seed generally grow very tall, hence offer difficulties in harvesting. Also, they produce variable yields of fiber of variable quality. The plants grown from cuttings have weak root systems and do not stand up well against heavy winds. Also, to propagate by cuttings is a rather slow process.

Realizing these drawbacks a study of two other methods of asexual propagation, budding and grafting was made.

The writer failed to find any reports, published or in manuscript, on the propagation of kapok by budding or grafting in the Philippines, or in any other country. When Doctor Mendiola, Head of the Department of Agronomy in this College, returned from his second visit to Java in 1927, he reported verbally to the Plant Breeding staff of this department that the Central Agricultural Experiment Station of Java had been experimenting on the propagation of kapok by budding, using as one of the stocks the Surinam kapok, *Ceiba pentandra* variety *Caribaea*. Doctor Mendiola suggested then to the writer that a similar experiment be carried out here. He had brought with him four living plants of the Surinam kapok which he planted near Cottage No. 5 on Faculty Hill for possible use in the future

[1] Experiment Station contribution No. 960. Prepared in the Department of Agronomy under the direction of Dr. N. B. Mendiola. Received for publication January 10, 1934.

for budding.[2] Following his suggestion, this work was undertaken using patch budding or cleft grafting, and the present paper was prepared embodying the results. The work was carried for two years and four months in the College of Agriculture at Los Baños, Laguna.

MATERIALS AND METHODS

Materials used

In this experiment 168 kapok seedlings generously given to the College of Agriculture by the School of Forestry at Los Baños were used and budded. The seedlings were transplanted in the Plant Breeding Garden plots until ready for budding. The seedlings used as stocks varied in diameter from 1.5 to 2.5 cm. at a point 30 cm. above the ground.

The bud sticks from upright and horizontal branches and having a diameter of from 2.5 to 3.0 cm. were taken from an old kapok tree of reputed high yielding ability growing on the College of Agriculture Campus. Buds or scions available for budding or grafting were counted. The buds found from a bud stick a meter long were used for patch budding, and two scions from each small branch were used for cleft grafting.

Method of patch budding

The patch budding method was employed in this experiment. The process may be described as follows (see fig. 1): On each stock, at a point about 30 cm. above the ground, a piece of bark was separated cutting downward. The separated bark was about 1.5 cm. wide and 3 to 4 cm. long. From the bud stick a piece of bark containing a dormant bud was removed including a part of the woody portion. The woody portion was then carefully removed from the bark. This bark containing the bud was made rectangular in shape and a little smaller in size than the wound. The scion was attached immediately at normal position to the woody portion exposed. This scion was then held in place by the bark and tied tightly with a piece of budding tape. The whole wound was kept covered with the budding tape to prevent water from getting into it.

---

[2] At the present writing, these Surinam kapok plants are about seven years old. They have reached a height of about 12 meters and have a stem diameter of 35 cm. at the base. They appear to have a more vigorous and compact growth than ordinary kapok but they have not flowered. This variety of kapok is a shy bearer in Java; it fruits at long intervals of years and my latest information is that this undesirable characteristic seems to be transmitted by Surinam kapok stocks to the ordinary kapok scion. I am now killing three of the four plants I introduced and leaving only one for possible use in the future. This kapok, like the ordinary variety, is easily propagated by large cuttings.—*N. B. Mendiola.*

Method of cleft grafting

Small branches of the mother plant were also tried for cleft grafting, the method followed was: The scion was cut wedge-shaped and the length of the cut varied from 3 to 4 cm. The length of the scion varied from 10 to 15 cm., with all the leaves removed.

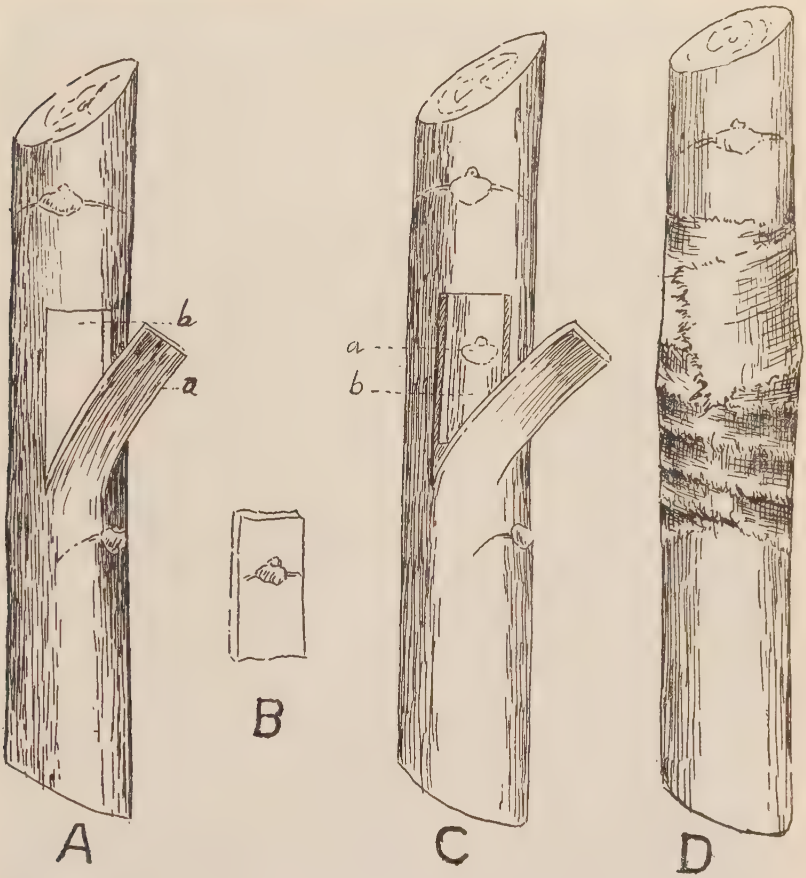


Fig. 1.—(*A*) A portion of kapok seedling showing (*a*) the split bark, and (*b*) the exposed woody portion. (*B*) A scion from the bud wood showing the bud ready for insertion. (*C*) (*a*) The correct position of the inserted bud and (*b*) the inserted scion. (*D*) The budded portion of the kapok seedling tightly covered with budding tape.

About 25 cm. above the ground, the stock was cut with a sharp knife at a right angle to its axis. With the blade of the knife the cut was opened downward about the length of the wedge; the prepared scion was inserted, placing it very carefully so that the two cam-

bium layers, that of the stock and that of the scion, came in contact. The wound was first tied with twine then wrapped with grafting tape. Wrapping was started at the lower end, proceeding upward until the whole wound was protected.

Observations

About two weeks after budding or grafting, the tape covering the scions was removed and the condition of the scions noted. At this time the inserted buds were considered successful if they were green. The budded or grafted seedlings were examined often and protected from any possible injury. When the patch was greenish and it seemed sure that the bud would develop, the main stem of the stock was cut 5 cm. above the budded portion. When the bud was about 3 cm. in height, the remaining stem was pruned just above the growing bud. The wound was coated with tar. The treated trees were transplanted later, and thereafter observations were made on the growth of the buds, branching habits and height of the budded trees as compared with the unbudded ones. The fruiting of the treated and untreated trees was also noted.

RESULTS

Results of this experiment are found in tables 1, 2, and 3.

Table 1 gives the number of scions available for budding and grafting from a branch of kapok plant having a diameter of from 2.5 to 3 cm. at its base.

Table 2 gives the percentages of developing buds.

Table 3 gives the height of the developing buds at the age of one and one-half to two months.

DISCUSSIONS OF RESULTS

Scions available and success obtained by patch budding and cleft grafting

As shown in table 1, a meter of bud stick of kapok produced from 29 to 50 buds which were available for patch budding. On an average about 40 buds could be used for this purpose. At the same time, from the same kind of bud stick as many as 22 smaller branches could be utilized for grafting, the average was around 13 scions.

It may be seen from table 2 that the kapok plant responded to patch budding more readily than to cleft grafting. Eighty-nine per cent or 124 of the 138 buds used were successful. With cleft grafting, only 70 per cent or 21 of the 30 scions used developed. The success of developing buds by patch budding was 19.13 per cent greater than that by grafting.

The above data seem to show that by patch budding the propagating power of the kapok plant could be increased around 40 times and by cleft grafting 13 times the ordinary method of propagation by cuttings. By using patch budding and grafting methods of propagation together, a branch of kapok could be propagated about 50 times.

Fig. 2.—A budded kapok tree at the age of five years. Note the developing flower buds.

Characteristics of the budded or grafted and untreated plants

It may be seen in table 3 that at the age of about two months, the growing buds varied in height. At this age some of the inserted

buds remained green but did not develop, while others grew from 3.5 to 60 cm. tall. Some of the buds at the age of one and one-half months grew faster than some that had been inserted two months.

These data seem to show that, although the buds remained green, not all developed to young plants. The rate of growth of the buds varied considerably and seemed to depend not only upon the age of the scions inserted but also upon other factors not investigated in this study.

It is interesting to note that scions from an upright branch developed into upright trees, while those from an horizontal branch generally produced drooping branches. The budded or grafted trees from scions of upright branches were taller than those from the drooping ones.

The budded and grafted trees attained a height of over a meter and a half at the age of one year and produced many branches. They started to produce well developed pods after a year and continued to fruit yearly. The budded trees were much shorter and the branches produced were closely arranged and less stout than those grown from seed (see fig. 2 and 3). These characteristics are highly desirable as the harvesting of the ripe pods is more convenient and the trees are less exposed to heavy winds than when tall.

SUMMARY AND CONCLUSION

The kapok plant responded to patch budding and grafting readily. The rate of asexual propagation of this plant can be increased about 40 times by patch budding alone and many more times if all the small branches are utilized for grafting. The budded trees started to produce pods when the scion reached the age of about one year and continued to fruit yearly. The budded trees, being comparatively low, are less subject to injury by heavy winds. Scions from the upright branches produced upright growths. Patch budding or cleft grafting, or both may be recommended for propagating the desirable kapok trees or varieties.

Fig. 3.—A five-year old kapok tree grown from seed.

TABLE 1

Number of scions available for budding and grafting from a branch of kapok plant [a]

NUMBER OF BRANCHES STUDIED	BUDS OR SCIONS AVAILABLE FOR	
	budding	grafting
1	50	22
2	65	17
3	31	9
4	33	9
5	32	14
6	29	8
Average	40	13

[a] The diameter of the branches used in counting the available buds or scions was from 2.5 to 3 cm.

TABLE 2

Showing the percentage of developing buds

CHARACTERS NOTED	BUDDING	GRAFTING
Number of inserted scions	138	30
Number of green or developing buds	124	21
Developing buds, per cent	89	70

TABLE 3

Height of the inserted buds at the age of one and one-half to two months

STOCK NO.	AGE	HEIGHT OF BUD	STOCK NO.	AGE	HEIGHT OF BUD
	days	*cm.*		*days*	*cm.*
59	41	14.5	45	54	60.5
140	44	27.0	19	57	30.5
141	44	25.5	20	57	28.0
106	46	34.5	125	62	7.5
107	46	23.0	129	62	15.9
122	46	19.5	134	62	22.5
128	46	18.8	78	64	17.0
136	46	40.0	83	64	16.3
137	46	28.5	85	64	12.5
56	49	26.0	87	64	11.0
57	49	32.0	55	65	17.0
62	49	30.0	58	65	22.5
63	49	30.5	60	65	12.0
66	49	26.5	61	65	19.5
21	49	26.5	64	65	23.5
22	49	34.3	65	65	18.0
24	49	16.0	23	66	24.5
25	49	29.8	32	66	3.5
26	49	29.8	33	—	40.5
31	49	30.7	34	—	25.2
46	51	27.7	35	—	59.0
47	51	23.0	36	—	19.5
41	54	47.5	37	—	35.5
42	54	33.0	39	—	54.0
43	54	28.0	38	—	19.0

A STUDY OF PEANUT AND INDIGOFERA HENDECAPHYLLA JACQ. AS FORAGE CROPS[1]

ABELARDO J. FAJARDO

WITH ONE TEXT FIGURE

It is part of intelligent farming to improve the quality of feed for live stock by producing forage crops from legumes which can be successfully grown locally. Peanut and *Indigofera hendecaphylla* Jacq. thrive well under Philippine conditions. There is little information, however, on the production and palatability of the different varieties of peanuts and *Indigofera hendecaphylla*.

According to Elayda (1916) peanut was grown extensively in Batangas, the nuts being utilized for human consumption and the forage cured as hay for horses. And Tuya (1930) found in feeding trials with horses that peanut hay is less palatable than Guinea grass (*Panicum maximum*), corn fodder (*Zea mays*), barit (*Leersia hexandra*), sugar cane top (*Saccharum officinarum*), Para grass (*Panicum barbinode*), Napier grass (*Pennisetum purpureum*), or culape (*Paspalum conjugatum*). Chemical analysis shows that the peanut hay contains 11.04 per cent moisture, 8.57 per cent ash, 11.38 per cent crude protein, 32.61 per cent crude fiber, 33.84 per cent nitrogen free-extract and 2.56 per cent fats (ether extract).

From other countries where much has been written on the peanut the following three items of information are cited. Nerowan (1926) of the Arkansas Agricultural Experiment Station states that hay of peanut vine has a breeding value similar to that of alfalfa and clover. It is better than a ration composed of ordinary hay and corn for horses and mules.

According to the International Library of Technology (1911) if peanut vines are cut too early, the hay produced will be deficient in dry matter; the stem and leaves will be so watery that they will shrink excessively in curing. On the other hand, if cut too late the hay will be woody, unpalatable and hard to digest.

According to Heyne (1927) *Indigofera hendecaphylla* Jacq. is used as cover crop for coffee, rubber, oil palm, agave and tea planta-

---

[1] Thesis presented for graduation, 1931, with the degree of Bachelor of Agriculture from the College of Agriculture No. 385; Experiment Station contribution No. 961. Prepared in the Departments of Agronomy and Animal Husbandry under the direction of Mr. Vicente B. Aragon and Dr. Valente Villegas.

tions in Java. It grows luxuriantly and is resistant to drought and wet conditions. It grows well in clayey land and may be grown with good results up to 6,000 feet elevation.

THE PRESENT WORK

The objects of the investigation here reported were: (*a*) to determine the yield in nuts and forage of three Philippine varieties of peanuts, and the forage yield of *Indigofera hendecaphylla* Jacq.; (*b*) to ascertain the relative palatability of the hays as forage crops for horses; (*c*) to find out the comparative nutritive value of these hays as shown by chemical analysis.

The work was carried out at the College of Agriculture, University of the Philippines. It covered a period of eleven months, from October, 1930 to August, 1931.

MATERIALS AND METHODS

Varieties of peanut

The three varieties of peanuts used were: Tagalog, Kinorales and Angat.

Tagalog. Being a runner type, this plant branches freely, the lateral branches spreading from 60 to 90 cm. The middle branches tend to shoot upward. The stems are green, roundish and measure about 0.5 cm. in circumference, and are soft and brittle. The fruits are long and slender with very distinct ridges and rugae containing from three to four seeds each. The leaves are small and somewhat elongated.

Kinorales. This variety belongs to the bunchy type and does not produce as much vegetative growth as the Tagalog variety. The branches are from 40 to 60 cm. long and are upright in position. The stem is large, about 0.5 to 0.7 cm. in circumference, angular in shape, purple in color, and scantily pubescent, and is hard. The leaves are larger than those of Tagalog variety. The fruits are about 2.5 by 1.4 cm., with less distinct ridges than the Tagalog variety and rugae containing not more than two reddish seeds.

Angat. This plant is a runner type and branches more than the Tagalog variety. It has good vegetative growth. The foliage is thicker than that of the Tagalog variety. The lateral branches spread from 80 to 100 cm. The middle branches crawl instead of shooting upward. It has a dark yellow foliage. The stem resembles that of the Tagalog variety in size. The leaflets are elliptical. The margin is strongly ciliate. The pods are variable in size, the largest

being about 5 to 15 cm., with very shallow ridges and rugae. They contain one or two seeds each. The stem is harder than that of the Tagalog variety.

Indigofera hendecaphylla

The *Indigofera hendecaphylla* used for planting material in this work was introduced on August 23, 1927 into the College of Agriculture from Java by Dr. N. B. Mendiola of the College Faculty.

Figure 1 shows a branch of *Indigofera hendecaphylla*. It is an annual or biennial creeping plant with trailing stems 60 to 120 cm. long. Leaves are nearly sessile, 5–7 cm. long; the leaflets are 5–9 oblanceolate, alternate membranous, obtuse, 1.5–2 cm. long, with a few

Fig. 1.—*Indigofera hendecaphylla* Jacq.

depressed grey hairs. The stipules are about 1 cm. long, lanceolate, acuminate. The corolla is violet-purple, twice the size of the calix. Pods are deflexed, 3–4 cm. long containing 6–10 seeds. Flowering takes place at the beginning of the dry season. The root system comprises a large central root, called a tap root, from which numerous branches develop at varying distances. The roots under favorable conditions bear tubercles. These tubercles or nodules contain certain forms of soil bacteria.

Unlike other leguminous plants, *Indigofera hendecaphylla* possesses the following characteristics: (1) It is a heavy yielder of forage; (2) it can stand pasturing and trampling during harvest-

ing or cutting; (3) like camote it will rejuvenate from vines; (4) it can be available any time of the year; (5) being a leguminous plant it can fit in rotation with any crop; (6) when fed to animals no bad effects are produced; (7) chemical analysis shows that this plant is rich in nutrients; (8) the plant is eaten by domestic live stock.

Culture of the forages used

Cultivation of peanut. The soil used for peanuts in this experiment was clay loam, which was compact, tending to harden during the dry season. The land was first plowed with a tractor to an approximate depth of from 15 to 20 cm. After three weeks it was plowed again, harrowed and furrowed; this tillage put it in good condition for peanut growing.

Planting was done in October, 1930, which is the usual month for planting peanuts in Batangas. The three varieties were set 50 cm. apart in rows that were 100 cm. from each other. Kinorales being of the bunchy type could have been planted closer. Shelled nuts were used for planting.

The peanut requires the same cultivation as corn. The first cultivation by spike-tooth harrow was twenty-nine days after planting. By this time the plants were about 25 to 35 cm. high and could stand shallow cultivation. In the second cultivation which was 20 days after the first a native plow was used. The soil was worked toward the rows. This operation was found effective in eradicating the weeds in ridging the plants. As soon as the pods were formed, cultivation was discontinued.

Inasmuch as a belief exists among the Batangas farmers that unshelled peanuts for seed give more yield than the shelled, a separate lot was planted with the Tagalog variety using both unshelled and shelled. With shelled, three seeds were placed in each hill, and with the unshelled five. The distance between plants and the methods of cultivation were the same as those followed with the other planting.

Harvesting of peanuts. The fruits were harvested by turning over the plant in rows with a native plow. Laborers followed the plow and separated the vines from the soil by hand. To prevent excessive drying, the vines were stacked to a height of only about 1.5 meters in the field. The fruits were then separated from the vines, and the vines cut off about 10 cm. above the base of the roots. The cut vine and the nuts were weighed at once. After weighing the green vines in each lot, they were taken to the storehouse for curing.

One of the important things in the production of hay crops is to determine the proper time for harvesting. To produce a good hay a number of factors should be considered, as the character of the crop, the condition of the soil, that is, dry or damp, and the amount of sunlight. Also harvesting should take place, if possible, when the largest amount of digestible nutrients is present in the plant and when the largest amount of forage can be obtained.

With the peanut the fruits must be considered as they should be sufficiently mature for human consumption. Voorhees (1907) stated that this condition can be obtained if the plants are cut while in blossom, although the largest total yield per acre cannot be secured at this time. The procedure followed in this work was to harvest the peanut when the pods were just beginning to mature and the top leaves were still greenish in color.

Cultivation of Indigofera hendecaphylla. This legume is exacting as to soil requirement. It grows well in clayey soil (Heyne, 1927) which was used in this work.

Planting may be done either by seeds or by cuttings. Using seeds involves more time because of shelling so is uneconomical. The recommended practice is to plant cuttings about 30 cm. long. Longer cuttings dry up before they can develop roots. The younger shoots or branches are preferable to older branches because they develop roots easier. The cuttings in this study were planted 30 cm. apart in the furrow and the rows were 60 cm. apart. Five to seven cuttings were planted in each hill. Fifteen gunny sacks full of cuttings were enough to plant one-fourth hectare.

Because of the creeping habit of the vines the crop was cultivated by hand. It covers the whole space between the rows, hence the use of animal drawn cultivator is impracticable.

Harvesting of Indigofera hendecaphylla. Other forage crops should be harvested after attaining a certain definite age. This plant can be cut any time after it has developed abundant luxuriant vines. This legume being a creeping plant, the continuous production of young branches is unnatural, so at harvest time a mixture of young and old stems is unavoidable. In this study the plants were harvested nine months after the date of planting. Had the plantings been made in the early part of the rainy season harvesting would have been possible within a shorter period.

A sickle was used in harvesting. The vines were cut about 60 cm. long, cutting only the green portions. The second cutting was done forty-five to sixty days after the first cutting.

To determine the production per hectare of this forage, the harvested roughage was weighed immediately after cutting the vines.

Curing of forages. The loss of moisture during the early stage of curing is great. When dried in stacks the warm air in the material causes further transpiration or giving off of moisture during the night. To make the feed palatable and nutritious for live stock the hay should be greenish in color and sweet in smell when drying is stopped. As rapid drying renders the hay odorless it must be dried in stacks and not scattered over the curing floor, otherwise the aroma will be lost. If dried in stacks the loss of moisture is gradual and the aroma is thus preserved in the hay.

The vines were dried in the sun and stored under a shed at night. When the hay appeared fairly dry, it was no longer put out in the sun. Curing was continued in the shed until the amount of moisture in the samples was 63.53 per cent in the Tagalog peanut, 82.81 per cent in the Kinorales, 58.03 per cent in the Angat, and 65.06 per cent in the *Indigofera hendecaphylla.*

Baling of forages. For baling, a hay press or hay baler was used. The hay was compressed by a plunger to the proper size and the bales tied with wire. Different weights of bales were prepared; a large bale weighed 40 to 45 kgm., a medium one, from 25 to 35 kgm., and a small one, from 15 to 20 kgm.

Moisture determination of forages

In order to be able to express accurately the yield of dry hay produced from the green material harvested, the use of the sample method as reported by Vinal and Roland (1916) was used. A sample of each forage was taken at the time the harvested green material was weighed. The loss of moisture after the material had been air dried was then determined. With these data, the yields were reduced to air-dry basis.

In sampling, care was taken to get the representative sample of each kind of forage. The samples were prepared in triplicate. Each sample was marked with a tag bearing a number and other necessary information. The initial weight was then taken. Cheese cloth bags 50 × 90 cm. in size were used for containers. The samples were dried in the sun every day when weather permitted. When air dried and sufficiently well cured the bags were again weighed and the difference between the first and second weighing represented the loss of moisture. This method eliminates the possibility of loss of weight owing to loss of leaves in handling. The bags were thin enough so that the heat of the sun could penetrate and dry the material inside.

Plan of palatability test

One set of experiments was carried out to find the palatability of these forages. In this test four Philippine horses which were known to have normal feeding habits were used. The four different forages were given to the horses at the same time. A preliminary feeding period of five days was made before actual records were taken. The feeding trials were conducted at the Animal Husbandry Department stable. Feeding was conducted during the day in boxstalls 2 × 3 meters in size. Early in the morning the horses were turned loose in paddocks for exercise, after which they were placed in boxstalls for feeding. The hays were placed in mangers which were so partitioned as to separate the different varieties under trial. The morning supply was given at seven o'clock and the afternoon allowance at one o'clock. Enough of the hays was provided so that the animals had all they could consume. At five o'clock the horses were taken from the boxstalls and exercised in the open. At this time the left-overs were weighed, the difference in weight between the amount given and that remaining in the manger being the amount eaten by the animals. The horses were again placed in the boxstalls for the night. A small allowance of rice bran or corn was given to them. Water was supplied in the morning and afternoon. They had access to salt at all times.

To find out if the horses were doing well with the feed their general health was observed. The initial and final weights of the animals represented by the average of the three weighings at the beginning and end of the test were taken.

DISCUSSION OF RESULTS

Moisture content of hays

The losses of moisture in air drying, or curing hays of the three varieties of peanuts and *Indigofera hendecaphylla* Jacq. are given in table 1. Examination of the data presented shows clearly that of the three peanut varieties, the greatest loss of moisture was in Kinorales peanut and the smallest loss in the Angat variety. The loss was 82.81 per cent in the Kinorales peanut, 63.43 per cent in the Tagalog variety, and 58.03 per cent in the Angat. *Indigofera hendecaphylla* showed an average loss of 65.06 per cent.

Comparative yield of nuts and hay and the age at harvesting

Careful examination of table 2 shows that the age at the time of harvesting varied according to the variety of peanut. The Tagalog peanut matured in 159 days, Angat, in 141, and Kinorales, in 106.

Indigofera hendecaphylla was ready for harvesting in 296 days after planting. In Java, according to Heyne (1927) *Indigofera hendecaphylla* covers the ground in 6 months, or 180 days. It took a longer period for this plant to make the same growth in this study because it was planted in November when the weather was rather dry and consequently the growth was slow. Rapid growth of the forage took place from June to August when there was rain. The best time to plant this forage is just before the rainy season.

As with the hay, the yield of nuts in the different peanut varieties was not the same. Among the three varieties the Tagalog peanut was not only a good producer of stem but also of nuts. Kinorales was a good producer of nuts but poor stem yielder. The Angat variety, although it produced longer branches than the Tagalog variety, did not produce as thick a foliage. It produced fewer nuts and less stem than the Tagalog. *Indigofera hendecaphylla* was a heavy yielder of hay compared with any one of the peanut varieties.

Table 3 shows the difference in production of forage and nuts of the Tagalog peanut when shelled and unshelled nuts were planted. When shelled nuts were used the production per hectare of fresh forage was 3,003.00 kgm., when the unshelled nuts were planted, 3,672.80 kgm. The corresponding yields of hay per hectare was 1,102.75 kgm. from the shelled nut area and 1,339.60 kgm. from the area planted to unshelled nuts. A very marked advantage in nut production was obtained with the plants from unshelled nuts, from which the yield per hectare was 700.40 kgm. and with shelled nuts the production was 455.00 kgm. per hectare.

Palatability

Table 4 shows the average daily consumption of hays of the three varieties of peanuts and *Indigofera hendecaphylla*. From this table it is apparent that the most palatable hay was from the Tagalog peanut, the average daily consumption per horse being 46.80 per cent. The Angat peanut ranked second in palatability, 25.22 per cent being consumed by each horse daily. The poorest in palatability was the Kinorales, the average daily consumption being only 15.73 per cent per head. Of the hays tested that of *Indigofera hendecaphylla* was found to be the lowest in palatability, the average consumption amounting to 12.26 per cent per head daily. The averages, however, were not necessarily the same with all the horses. For instance, in the case of horse, Herd No. 26, the least palatable hay was the Tagalog variety of peanut, the consumption of which was 5.91 per cent. Of the four horses, this animal showed prac-

tically the same percentage consumption of Kinorales and Angat peanuts, and consumed the greatest amount of *Indigofera hendecaphylla*. With the other three horses the trend of consumption of the different varieties of peanut and *Indigofera hendecaphylla* was the same.

Chemical analysis

The chemical composition of the feeds is influenced by a number of factors; namely, the age at which the forage was harvested, method of curing, and the fertility of the soil. It is very important that the chemical analysis of the forages be compared to determine the relative value of the different feeding stuffs given to the animals.

Table 5 shows the composition of the different forages studied, both the green forage and cured hays. Analysis was made for the moisture, fat, (ether extract), ash, crude protein and crude fiber contents in the Agricultural Experiment Station Analytical Laboratory.

The analysis shows different chemical composition of the green and the cured forages. That is, the nutritive value of the different forages increases when they are in the hay form owing to the cured material being drier.

SUMMARY OF CONCLUSIONS

1. The age at the time of harvest of *Indigofera hendecaphylla* was 296 days; of the Tagalog variety of peanut, 159 days; of the Angat, 141 days; of the Kinorales, 106 days.

2. The yield of nuts differed slightly in each variety. It was 700.40 kgm. with the Tagalog variety, 696.33 kgm. with the Kinorales variety, and 658.70 kgm. with the Angat variety.

3. The highest yield of fresh forage per hectare, 3,672.80 kgm. was obtained with the Tagalog peanut, the Angat ranking next in production with 2,409 kgm. The lowest yield, 596.83 kgm., was from the Kinorales variety. *Indigofera hendecaphylla* produced 12,738.8 kgm.

4. With the three varieties of peanut used, the Tagalog variety produced 1,339.60 kgm. of hay per hectare, the Angat variety, 1,011 kgm. and the Kinorales 102.66 kgm., *Indigofera hendecaphylla* produced 4,451.2 kgm.

5. The percentages of the loss of moisture from the fresh material to air-dry hay was 82.81 in the Kinorales variety, 63.43 in the Tagalog, 58.03 in the Angat and 65.06 in the *Indigofera hendecaphylla*.

6. The seeds of the Tagalog peanut were planted both unshelled and shelled. The unshelled produced 700.40 kgm. of nuts per hectare and the shelled, 455.00 kgm.

7. Using the shelled peanuts for planting material, the Tagalog variety produced 3,003.0 kgm. of fresh forage per hectare, and using the unshelled nuts, 3,672.80 kgm.

8. Comparing the production of hay from shelled and unshelled planting material, the Tagalog peanut, shelled, produced 1,102.75 kgm. the unshelled, 1,339.60 kgm.

9. According to consumption records the relative palatability of the different hays tested may be summed up:

(*a*) Tagalog peanut hay proved to be the most palatable of all. (*b*) Angat peanut hay was more palatable than either *Indigofera hendecaphylla* or Kinorales peanut. (*c*) Kinorales peanut hay was more palatable than *Indigofera hendecaphylla.* (*d*) *Indigofera hendecaphylla* was the least palatable of all.

10. The relative order of the different constituents in the forages analyzed are summarized below:

Moisture: *Fresh forage*: (1) Angat hay; (2) Kinorales hay; (3) Tagalog hay; (4) *Indigofera hendecaphylla. Hay*: (1) Tagalog hay; (2) Angat hay; (3) *Indigofera hendecaphylla;* (3) Kinorales hay.

Fats: *Fresh forage*: (1) Angat hay; (2) Kinorales hay; (3) Tagalog hay; (4) *Indigofera hendecaphylla. Hay*: (1) Kinorales hay; (2) *Indigofera hendecaphylla;* (3) Angat hay; (4) Tagalog hay.

Ash: *Fresh forage*: (1) *Indigofera hendecaphylla;* (2) Tagalog hay; (3) Angat hay; (4) Kinorales hay. *Hay*: (1) Angat hay; (2) Tagalog hay; (3) Kinorales hay; (4) *Indigofera hendecaphylla.*

Crude protein: *Fresh forage*: (1) *Indigofera hendecaphylla;* (2) Angat hay; (3) Tagalog hay; (4) Kinorales hay. *Hay*: (1) Angat hay; (2) Tagalog hay; (3) Kinorales hay; (4) *Indigofera hendecaphylla.*

Crude fiber: *Fresh forage*: (1) *Indigofera hendecaphylla;* (2) Kinorales hay; (3) Tagalog hay; (4) Angat hay. *Hay*: (1) *Indigofera hendecaphylla;* (2) Kinorales hay; (3) Angat hay; (4) Tagalog hay.

Nitrogen free-extract: *Fresh forage*: (1) Tagalog hay; (2) Kinorales hay; (3) *Indigofera hendecaphylla;* (4) Angat hay. *Hay*: (1) Tagalog hay; (2) Angat hay; (3) *Indigofera hendecaphylla;* (4) Kinorales hay.

LITERATURE CITED

ANONYMOUS. 1911. International library of technology. VI + 482 p., 231 fig. Scranton: International Text Book Company.

ELAYDA, INOCENCIO R. A preliminary study of forage crops. (Thesis presented for graduation from the College of Agriculture with the degree of Master of Science in Agriculture. 1916. Unpublished.)

HENRY, W. A., AND F. B. MORRISON. 1929. Feeds and feeding. Abridged. 6th. ed., VIII + 440 p., 114 fig. Madison, Wisconsin: The Henry Morrison Company.

HEYNE, K. 1927. De nuttige planten van Nederlandsch Indie. vol. 2: 774-775, 773-1450 p. Buitenzorg: Department van Landbouw, Nijoverheid en Handel.

TUYA, MANUEL. A comparative study of the palatability and proximate analysis of common forages. (Thesis presented for graduation from the College of Agriculture with the degree of Bachelor of Agriculture. 1930. Unpublished.)

VINALL, H. N., AND R. MCKEE. 1916. Moisture content and shrinkage of forage and the relation of these factors to the accuracy of experimental data. U. S. Dept. Agric. Exper. Sta. Bull. 353: 1–37.

VOORHEES, E. B. 1907. Forage crops. XIII + 394 p., 64 fig. New York: The Macmillan Company.

TABLE 1

Showing loss of moisture in air-drying or curing peanut forages and Indigofera hendecaphylla

FORAGE	SAMPLE NO.	WEIGHT OF SAMPLE		MOISTURE LOST	
		Original	Air dry	Weight	Per cent
		grams	*grams*	*grams*	
Peanut varieties:					
Tagalog	1	3,500	1,350	2,150	61.29
	2	3,500	1,198	2,302	65.77
	3	3,500	1,277	2,223	63.52
	Average	3,500	1,275	2,225	63.43
Kinorales	1	11,000	1,793	9,207	83.70
	2	11,000	1,987	9,013	81.94
	3	11,000	1,893	9,107	82.79
	Average	11,000	1,890	9,109	82.81
Angat	1	3,000	1,580	2,220	58.42
	2	3,600	1,702	1,898	52.73
	3	3,400	1,260	2,140	62.94
	Average	3,600	1,514	2,086	58.03
Indigofera hendecaphylla	1	3,200	1,100	2,110	65.63
	2	2,800	985	1,815	64.82
	3	3,500	1,235	2,265	64.72
	Average	3,167	1,107	2,067	65.06

TABLE 2

Showing age at time of harvesting, area planted, and comparative yield of nut, fresh forage and hay

FORAGE	DATE PLANTED	DATE HARVESTED	DURATION	AREA PLANTED	FRESH FORAGE HARVESTED	HAY PRODUCED	NUTS HARVESTED	PRODUCTION PER HA. OF FRESH FORAGE	PRODUCTION PER HA. OF HAY	PRODUCTION PER HA. OF NUTS
			days	*sq. m.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
Peanut varieties:										
Tagalog	Oct. 16, '30	Mar. 24, '31	159	2,500	918.20	334.90	175.10	3,672.80	1,339.60	700.40
Kinorales	Nov. 10, '30	Feb. 11, '31	106	1,200	71.62	12.32	83.30	596.83	102.83	696.33
Angat	Nov. 28, '30	Apr. 12, '31	141	1,998	481.20	208.00	131.60	2,409.00	1,011.00	658.70
Indigofera hendecaphylla	Nov. 28, '30	Aug. 25, '31	296	2,500	3,184.7	1,113.8	—	12,738.8	4,451.2	—

TABLE 3

Showing the comparative yield of fresh forages, hays and nuts of Tagalog peanut when shelled and unshelled nuts were planted

PLANTING MATERIAL	AREA PLANTED	FRESH FORAGE HARVESTED	NUTS PRODUCED	HAY PRODUCED	PRODUCTION PER HA. OF FRESH FORAGE	PRODUCTION PER HA. OF HAY	PRODUCTION PER HA. OF NUTS
	sq. m.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
Unshelled	2,500	918.20	175.10	334.90	3,672.80	1,339.60	700.40
Shelled	1,998	600.00	90.90	220.32	3,003.00	1,102.75	455.00

TABLE 4

Showing average daily consumption of forages by experimental horses

HERD NAME AND NUMBER		INDIGOFERA HENDECAPHYLLA			PEANUT FORAGES								
					Kinorales			Angat			Tagalog		
		Duration	Amount consumed	Consumption	Duration	Quality	Consumption	Duration	Quality	Consumption	Duration	Quality	Consumption
		days	*grams*	*per cent*	*days*	*grams*	*per cent*	*days*	*grams*	*per cent*	*days*	*grams*	*per cent*
Countess	24	32	75.91	2.27	23	254.22	7.61	32	485.14	14.54	32	2,523.72	75.58
Tahil	25	32	195.08	7.34	23	283.83	10.67	32	455.34	17.12	32	1,724.95	64.87
Prince	17	32	274.84	10.51	23	320.87	12.28	32	949.48	36.37	32	1,066.37	40.83
Licus	26	26	251.31	28.91	26	281.27	32.35	26	285.46	32.83	26	51.38	5.91
Average			199.28	12.26		285.05	15.73		543.85	25.22		1,341.60	46.80

TABLE 5

Average proximate chemical analysis of peanut and Indigofera hendecaphylla forages

FORAGE	MOISTURE	ASH	CRUDE PROTEIN	CRUDE FIBER	NITROGEN FREE EXTRACT	FATS	CALORIFIC VALUE 100 GRAMS
			Green forage				
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*
Peanut varieties:							
Tagalog	64.72	3.69	3.23	8.48	18.63	0.25	92
Kinorales	65.93	2.38	2.96	10.05	18.39	0.29	90
Angat	67.95	2.75	5.32	7.15	16.29	0.54	94
Indigofera hendecaphylla	61.29	3.90	6.73	10.55	17.29	0.24	101
			Hay				
Peanut varieties:							
Tagalog	14.50	8.02	13.26	18.96	43.57	1.69	249
Kinorales	13.24	7.73	12.88	23.05	41.04	2.06	240
Angat	14.27	6.97	14.88	19.15	43.00	1.73	253
Indigofera hendecaphylla	14.13	8.24	9.38	23.64	42.75	1.86	231

A REVIEW: "CATO THE CENSOR ON FARMING" [1, 2]

"Cato's *De Agricultura* is a treatise on farming in Italy in the second century B. C. Although of literary and linguistic interest as the oldest prose work in the Latin language, it is not primarily a piece of literature, but a manual directly, and to all appearances solely, concerned with the technique of the industry." (From translator's *Introduction*).

The work is divided in to CLXII chapters, none long and many only one short paragraph. By topics, the treatise is divided into nine divisions: "Advice on farm purchase and absentee management;" "Development and equipment of the farm;" "Calendar of the year's work;" "The year's supplies;" "Requisites of good farming;" "Protection of the owner's interest under the contracts for harvesting and pressing olives;" "Recipes for farm and household;" Miscellaneous responsibilities of the absentee owner;" "Medical recipes."

Cato in his very brief preface gives his estimate of the farmer and farming thus:

> It is true that it would sometimes be better to seek a fortune in trade if it were not so subject to risk or again to lend money at interest if it were an honorable occupation. But our forefathers held this belief and enacted it into a law, that while a thief was compelled to repay double, one who loaned at interest had to repay fourfold. And when they were trying to praise a good man they called him a good farmer and a good tiller of the soil, and the one who received this compliment was considered to have received the highest praise.
>
> Now I esteem the merchant as active and keen to make money, but [consider him], as I have said before, exposed to risk and absolute ruin.
>
> Moreover, it is from among the farmers that the sturdiest men and keenest soldiers come, and the gain they make is the most blameless of all, the most secure, and the least provocative of envy, and the men engaged in this pursuit are least given to disaffection.

---

[1] General contribution from the College of Agriculture, No. 401.

[2] BREHAUT, ERNEST. 1933. Cato the Censor on farming. (Translation of *De Agricultura*). xlvi + 156 p., 7 fig. New York; Columbia University Press, \$3.75 (₱7.50).

This book is No. 18 of series, *Records of Civilization, Sources and Studies* edited under auspices of the Department of History, Columbia University.

NOTE: Cato, the Censor, known also as the Elder and the Wise to distinguish him from his great-grandson, Cato of Utica, was of plebian birth. He inherited from his father a small estate which in his youth he cultivated with his own hands. During his public life he maintained a close interest in his estate or estates and made every exertion to promote and improve agriculture in the part of Italy under Roman rule. He was a voluminous writer, but *De Agricultura* is his only known work extant.

Cato's counsel on farming is not weighted with technical terms, nor is it a prettily worded sentimental homily on the charms of farm life and the farmers' value as the national backbone. No, indeed, it is a discourse, couched in the plainest words, giving practical directions on how to run a farm so it will pay. The directions are in the minutest detail on all phases, the field, house, labor, buying and selling, not omitting religious observances.

Under advice on buying a farm Cato emphasizes the importance of visiting a farm under consideration several times and going over it carefully before coming to a decision. He gives the following sound advice: "Notice carefully how prosperous the neighbors are; in a good district they should be quite prosperous. . . . It [the farm] should be near a thriving town or near the sea or a river where ships go up or a good and well-traveled highway."

The equipment should be noted carefully as an indicator of the prosperity or profit of the farm. "Be sure (on the other hand) that a farm is like a man, that however much it brings in, if it pays much out, not a great deal is left."

It is of interest to note that Cato recommends 100 *jugera* (about 25 hectares) as a practical size for a farm. The principal kinds of farming he considers are olive orchards and grape vineyards. The translator explains that one reason for Cato's full and explicit directions is that he was writing probably at about the time of the transition in central and southern Italy from the early grain farming to the olive and grape. The region which Cato considers is in Central Italy. Some directions are for certain definite farms, some may have been his own as he retired to one of his farms to write the treatise.

The farming in which he is principally interested is absentee landlord, that is, farms managed by a foreman, the owner living in a town or city. Indeed, many of the definite directions are to a foreman. Pliny, commenting on Cato's standard of qualifications of a foreman said he required him to be of an intelligence to nearly match his master's without himself being aware of it. Also, the foreman was not to be a "good fellow" socially. "The foreman should not be a stroller, he should never be drunk, and he should not go anywhere to dinner parties." "Be a good neighbor," the foreman is directed. Not, one concludes from the explanations, from any sense of human friendliness, but because it pays economically.

The labor was for most part slave labor. Certain parts of the work were performed under share contract, very little was paid labor.

The farm work animals were oxen and asses. Horses are mentioned three times and mules twice but nothing given as to their use. Hogs, goats, sheep and geese and pigeons and some chickens were raised. But live stock as a side line feature is not emphasized. Obviously feed for animals was a problem. Foliage of elm, oak and fig was the principal source of feed. There was some fodder crop feed, but apparently this source was not so important as the foliage. Dried wine press refuse and every variety of crop refuse were utilized. "There is nothing," wrote Cato, "that pays better than to take care of good work oxen."

As to implements and tools, Filipino farmers would be quite at home on Cato's farm. They might be surprised to find harrows with iron teeth; and there were iron shares to slip over some of the wooden plow shares. For hand work there were spades of different sizes, pronged hoes, shovels, axes, scythes, sickles and even bill-hooks for pruning trees. The equipment for taking care of the olives and making the wine forms a long list.

In the directions for many farm practices it is easy to forget one is not reading in a modern farm journal. The directions for layering of vines, cleft-grafting, bark-grafting, planting cuttings in nursery, pruning trees and vines, might, with few changes, be quoted in a 1934 farm paper.

In plowing, the farmer is told to "Turn the furrows to the far end and back without stopping the oxen." "When the soil is not productive add more cuttings (of olive trees) and plow the ground more." Under "Requisites of good farming," Cato's admonition is: "What is it to till the land well? It is to plow well. What next? To plow. What is the third? To manure . . . As for grain land, when you plow, plow it well and at the right time; do not plow when the furrow shows wet above and dry below.

"The rest of [good] farming is to do much hoeing and to be active in taking up young trees and vines at the right time and transplanting them with as many roots and as much earth as possible; and after you have filled in around the roots to tread the earth down well, so that water will do no harm."

Besides the money crops, olives and grapes, there were quinces, pears, pomegranates, figs, and beans, vetches, fenugreek, lentils, chick-peas, lupins, wheat and barley. Radishes, turnips and rape were grown for forage.

Cato's understanding of the importance of maintaining soil fertility is so admirably summed up in a footnote by the translator that the note is here quoted.

Nothing shows better that Cato's farming was not on a primitive basis than his stress on the necessity for the saving and use of manure, some phase of which is referred to in no less than 22 out of 162 chapters. The importance of manuring is further shown in the answer to the question as to what is good farming: namely 'in the first place, plowing; in the second place, plowing; third, manuring.'

The farm foreman is urged to 'try to have a big manure pile' and 'to save the manure carefully.' It was a task for the slaves in rainy weather and in winter before daylight 'to carry out the manure to the manure pile.' Every scrap of animal and vegetable refuse on the farm was concentrated here: droppings of pigeons, sheep, goats, pigs and work oxen, and of any other farm animals there might be; straw, lupin vines chaff, husks of one sort and another; leaves, especially of the evergreen oak and the deciduous oak which were not so suitable for forage. All the weeds and coarse grass that could be gathered had the same destination. Of these ingredients of the manure pile, pigeon manure seems to have been the most valuable, and might be sown separately almost as sparingly as seed. The manure was rotted well and taken out to the fields in panniers on the backs of donkeys.

Ashes is mentioned three times as being of value as a fertilizer. Lime was burned for building purposes but no mention is made of its use to benefit the soil.

Cato knew that legumes restore fertility. "What crops manure the field? Lupins, field beans, vetches." Apparently, the legumes were planted in rotation as there are no directions about plowing under.

The sixty-one "Recipes for farm and household" might be a direct ancestor of "The Family Doctor Book" so relied upon in the early pioneer homes in the United States. In this section many daily cares and worries of the Latin household in the second century B. C., stand revealed. The weaving in of superstitions does not lessen the interest. "If a work ox becomes sick give it at once one raw hen's egg." . . . "The ox himself and the man who gives the dose should stand erect. A fasting man should give the dose to a fasting ox."

As one has an aversion to being a solitary victim, a rather vicious pleasure is felt in reading directions on how "to keep moths from touching clothes," "to keep weevils from grain." "Use concentrated oil dregs to grease wagon axles, harness, shoes and hides. You will make them all better." This is not wholly unfamiliar advice. The counsel, "dogs should be shut up in the daytime so that they will be more alert and watchful at night," may be of interest to dog keepers. Through fourteen of the recipes light is thrown on the cooking of Cato's day. Of course, many recipes relate to wine and olives.

Cato was not one to trust to luck, many of his remedies are preventive. This is true also in his farming directions. He and "Poor Richard" were soul brothers in homely economics, though centuries apart in time and leagues apart in geography.

In the section, "Medical recipes," of which there are four, cabbage is the health preservative and cure-all *par excellence.* Under this recipe, or chapter there are sixteen prescriptions with cabbage *the* ingredient or factor. As an aid to digestion it "surpasses all others." "If you wish at a dinner party to drink a good deal and to dine freely, before the feast eat as much raw cabbage with vinegar as you wish, and likewise after you have feasted, eat about five leaves. It will make you as if you had eaten nothing and you shall drink as much as you please." Crushed cabbage leaf is recommended to be applied on wounds, tumors, ulcers and cancer. "It will cure them." "It will cure all inward pains." For these [the pains] cabbage should be taken in the morning before eating. It will also cure gout, remove wart from inside the nose; And "If you do not hear well, mix grated cabbage with wine and press the juice out and drop it, slightly warmed, into the ear; you will soon perceive that you hear better."

Cato advised that a farm should be self-sustaining so far as possible. "Everything that is suitable ought to be planted." Also, again and again he advises that no source of income, no matter how small should be overlooked. "Near the city, plant garden stuff of every sort, flowers for garlands of every sort." These garlands would be sold for festivals, weddings and celebrations. Vine trimmings were to be sold as firewood. Many other similar suggestions are made. "An owner should be a seller not a buyer." Again, he advises that worn out equipment, and old work oxen, even old slaves should be sold. Sentiment or humaneness, apparently, should not be encouraged in farmers.

Cato was no believer in loafing. "In rainy weather see what can be done at the farmstead. To prevent idleness do jobs of cleaning. Remember that when there is nothing being done the expense will go on none the less." In more than one chapter directions are given for rainy day work, such as preparing storage jars, cleaning buildings, cleaning seeds, making new ropes and repairing old. If there were no other odd jobs the slaves should mend their patchwork cloaks. (Cloaks were given out to slaves every other year, and patchwork cloaks were made out of the best parts of the old ones.) Festival days as part of religious observance must be observed, of course, but certain kinds of work are enumerated that can be done with propriety on these days.

"It is an advantage to the owner to have a well-built farmstead." "Build in such a way that the farm building will not find fault with the farm nor the farm with the building." The directions

for construction of farm houses, which were built of stone, lumber and with tiled roof, and of the olive pulping mill and wine press are most complete. In the directions for constructing an olive oil press is a paragraph telling in detail how to make a concrete foundation. A note by the translator on this paragraph states: "This passage is important as apparently the first literary evidence of the making of concrete."

An admirable introduction and full illuminating notes add to the value of this book which one cannot read without deep gratitude to the translator and to Cato the Censor.

EMMA S. YULE
Of the Department of English

We certainly ought not to treat living creatures like shoes or household goods, which, when worn out with use, we throw away; and were it only to learn benevolence to mankind, we should be merciful to other creatures. For my own part, I would not sell even an old ox that had labored for me.— PLUTARCH.

"Cow-protection should commence with ourselves. In no part of the world are cattle worse treated than in India. I have wept to see Hindu drivers goading their oxen with the iron points of their cruel sticks. The half-starved condition of the majority of our cattle is a disgrace to us."— LAJPAT RAI.

It is true that *most* fortunes have been made on credit. *All* failures have been made on it. Partial payment plans are of doubtful virtue. It is a hard lot to retire hungry, but it is better than lying awake worrying about paying for a full stomach. The future often is a most promising time, but too often we abuse and lean too heavily upon that promise.— KARL B. MUSSER.

The Guernsey Breeders' Journal March, 1934

If little labor, little are our gains;
Man's fortunes are according to his pains.

ABSTRACT[1]

Propagation of certain species of *Artocarpus* by marcottage. SEBASTIAN F. FABELLO. (*Thesis presented for graduation, 1929, with the degree of Bachelor of Science in Agriculture, from the College of Agriculture, No. 386; Experiment Station contribution No. 962*).—The author worked on the propagation by marcottage of nangka, *Artocarpus integra* Blanco, rimas, *A. communis* Frost, and marang, *A. odoratissima* Blanco. Both young and old branches of the three species were used. The young branches used were green in color and were from three to four cm. in diameter; the old branches were grayish or brownish in color and were from four to six cm. in diameter. Primary and lateral branches were used. Ringing and partial cutting methods were used on the species *integra* and *communis* but only the ringing method was used on the species *odoratissima*. Four kinds of treatments were used. In the first kind of treatment, the branches were covered with soil after the operation. In the second lot, the branches were covered after a callus formed over the wound of each branch. The third lot was treated with 5 per cent potassium permanganate solution for 24 hours before covering. The fourth lot was also treated with the same solution but the callus was allowed to form before covering. Both ringing and partial cutting methods were similarly treated. The number of branches was 20 in each lot, 10 of which were old and 10, young. One-half of each 10 was cut below the nodes and the other half was cut between the nodes.

The results were summarized as follows:

1. In *A. integra*, callus formed within 23 and 26 days with any of the treatments; and branches without treatment of potassium permanganate solution rooted within 98 and 111 days, and treated branches rooted within 92 and 98 days.

2. In *A. communis*, callus formed within 25 and 37 days, and rooting formed within 96 and 108 days on branches ringed and not treated with potassium permanganate solution, and within 92 and 97 days on branches ringed and treated.

[1] Abstract prepared as part of required theme work in English 3a, College of Agriculture.

3. Branches of *A. communis* with partial cutting formed roots within 112 and 123 days when not treated with potassium permanganate solution and within 108 and 111 days when treated.

4. *A. odoratissima* branches formed callus within 33 and 34 days, but did not root.

5. When ringed, young branches callused earlier than old branches, but there was no correlation between the earliness of callusing and the formation of roots.

6. Branches cut or ringed below the nodes gave a higher percentage of success than those cut between the nodes.

7. In general, the partial cutting method proved to be more satisfactory than the ringing method.

—*Abstract by Phanom Smitananda.*

KERNELS

"CORN FROM THE SHEAVES OF SCIENCE"

Philippine leafy vegetables are high in iron and manganese contents.

It needs only about 2.5 kilograms of feed to produce a dozen eggs from an ordinary flock of Los Baños Cantonese layers.

In pulverized tuff soil, the best stand of young lansones plants was obtained in an experiment when 57.2 grams of Ammo-Phos 13-48 per plant were used for fertilizer.

Cows which are not needed for breeding purposes can be unsexed, that is spayed, and fattened entirely on pasture grasses.

Latices from chico (*Achras saputa* Linn.), kalulot (*Artocarpus rubrovenia* Warb.), anubing (*Artocarpus cummingiana* Trec.), balete (*Ficus benjamina* Linn.), and malanangka (*Parartocarpus woodii* Merr.) may be used as chewing gum base.

The soybean plant is tender and the branches easily break. So, to get the maximum yield, this crop should be cultivated towards noon or early in the afternoon as the plant is tougher at this time and less subject to injury.

Mature kanduli (*Arius* spp.) has more fats than the immature and spent ones.

To get the maximum yield, peanuts should not be planted in the same field oftener than every other year.

Like rice, the young sugar cane plant can thrive well when supplied, in addition to all the essential elements, with nitrogen in two forms, as ammonium and as nitrate. Like rice, the young sugar cane plant absorbs nutrient solution in very low total concentration, as low as 0.002 gram-molecule.

From experiments on the hemoglobin content of the blood of the different breeds and crosses of cattle in the Department of Animal Husbandry it was concluded that the amount of hemoglobin content can be used as a guide in the selection of animals for adaptability to local environmental conditions.

CURRENT NOTES

A number of countries have gradually taken to the use of alcohol as a motor fuel. As a financial measure petrol importing countries have recognized that its use has the three advantages of reducing purchases of petrol abroad, increasing revenue through receipt of taxation on alcohol and benefiting agriculture at a time of overproduction, since alcohol is obtained from agricultural products containing sugar, starch or cellulose (beet, grapes, apples, potatoes, maize, rice, wood, etc.).

This spreading of the use of alcohol in motor fuel brings at the present time important help to agriculture, particularly in countries with an advanced agriculture. Apart from the use made of raw materials, there is the considerable residue available from the distilleries (pulp, etc.), which is utilizable as foodstuff for livestock. This is particularly the case with beets, potatoes and cereals. Moreover the alcohol industry does not have to be concentrated in large factories. Very often it takes the form of an agricultural industry which can be carried out on the farm along with other farm work. Finally, the industries of healthy drinks in greatest demand, wine and cider, benefit during years of over-production, as the surplus naturally goes to the still. The difficulty lies in striking a satisfactory equilibrium in accordance with circumstances in the utilization of the various sources of alcohol. This is an essentially economic problem into which we cannot enter here.

One last consideration deserves mention. The farmer is a producer of motor fuel but is also often a consumer. Tractors, trucks

and other automotive vehicles, and combustion engines, stationary or travelling, which work agricultural machinery, all use carburants. The alcohol which has been obligatorily added to petrol thus returns in part to the farm whence it came. Therefore, the uses for alcohol concern the farmer to the same extent as other users of automobiles, who, to the neglect of the farmer, are guarded as a rule as the chief users of the road.

International Review of Agriculture (Rome), January, 1934.

Cotton planting on a large scale is now being seriously considered in the Bicol provinces and in the Cagayan Valley, as a substitute crop for abaca and tobacco which are the main industries in those places, respectively. The planting of this crop is being urged by the Bureau of Plant Industry, owing to the low prices obtaining for both abaca and leaf tobacco.

Philippine Journal of Commerce, January, 1934.

As a rule, the addition of farmyard manure does not improve compost, because most of the material put in the heap consists of plants which contain all of their original nutriment, whereas farmyard manure consists of a mixture of the remains of plants after animals have extracted some of the nutriment and poor quality organic matter used as litter, such as straw, etc. The presence of some farmyard manure may tend to hasten decomposition, but this is generally rapid enough, provided that the heap is kept moist.

The Journal of the Department of Agriculture South of Australia, February, 1934.

Last year there were 40,656 motor vehicles registered in the Philippines, 24,865 automobiles, 15,237 trucks and 554 motorcycles. Among these were 3,156 new automobiles, 1,594 new trucks, 24 new motorcycles. Of automobiles, 97.9% come from the United States; of truck and bus chassis, 99.7%.

The American Chamber of Commerce Journal, March, 1934.

The goat is far more intelligent than the sheep, and much cleaner in habit than the cow. He will forage for himself in seasons when both these would starve and die. Certainly he may be troublesome. Unless they are well fenced, he will rob your gardens. In this he resembles the human boy. What could be more beautiful than the kids? No mother calls her children calves, and few call them lambs,

but "kids" is a term of endearment constantly used. To those who know beauty when they see it, the full-grown goat is a handsome animal. We should like to see his statue on a pedestal in every Western township. He deserves it, for is he not the saviour of your children? From goat's milk you can make the most delicious junket. Mix it with small pieces of fresh oranges, or uncooked ripe tomatoes, and see how your children take it. Kings' sons could have no better food.

Queensland Agricultural Journal, October, 1933.

The operation of pruning in banana culture is a fine art. It is so important, that its details should be planned for month by month, the supervision be as close as possible, and its execution only carried out by skilled people experienced in the work.

The objects of pruning, are—

1. The general welfare of the individual plant.
2. To ensure quality of the fruit.
3. Maximum size of bunches.
4. The proper timing of the crop and to a less important extent the provision of plants for future planting.

The knowledge of proper pruning is usually the last branch of banana cultural practice acquired by the banana planter or his supervisory staff and this is because of its many intricacies.

The alpha of good pruning is of course the proper planting of good suckers at the proper time.

The Journal of the Jamaica Agricultural Society, January, 1934.

COLLEGE AND ALUMNI NOTES

Mr. Pablo J. Noroña, Superintendent of the Davao Penal Colony was a visitor in the Agronomy Department in May. He came to obtain information about the culture of *palagad* rice, coffee, and fruits. He showed great interest in the high yield varieties of cassava in the College and the local manufacture of cassava starch and soap.

Mr. Rothkirch and Mr. Atanacio Carandang, B. S. A. '22, both from the Calamba Sugar Estate visited the College cassava field and starch factory on April 30. They made arrangements for the purchase of 9,200 meters of cassava cuttings from planting purposes in Canlubang.

In a letter to Doctor Fronda under date, April 17, Mr. Thongdee Resananda B. S. A. '24 wrote that he had been transferred from the Ministry of Public Instruction to the Ministry of Economic Affairs and appointed to the position of Acting Director General of the Department of Agriculture. With his usual modesty Mr. Resananda, or giving him his title Luang Suwan wrote:

"No one was more surprised than myself when acquainted of the fact by wire. I don't know why in the world I was chosen to tackle the job, especially when there are many seniors."

Undoubtedly the reason he was chosen to "tackle the job" is the type of work he has done in the two other jobs he was given to do in the past ten years, that of Principal of Korat Agricultural Teachers' Training School and establishing the new Experiment Station and Training School at Haidyai, in southern Siam.

Dr. N. B. Mendiola, Head, Department of Agronomy, has been invited by the President and Trustees of The American Museum and Natural History to become a member of the society. And Dr. Eulalio P. Baltazar also of the Agronomy Department, has been invited by President Ernest Minor Patterson to become a member of the American Academy of Political and Social Science.

On May 4, 1934, Dr. Paul Russell of the Rockefeller Foundation and Dr. P. I. de Jesus of the School of Hygiene and Public Health of the University of the Philippines visited the Campus according to previous arrangement, in connection with their work with malaria. The specific object of their visit was the shooting of scenes to Filipinize a film on malaria sent out by the Rockefeller Foundation. Scenes were shot in Copeland Heights Barrio on the Campus; on the Experimental Farm, on Faculty Hill children's playground and along Molawin Creek. Domingo Siapno, a senior, acted the part of the farmer who was ill with malaria and Mrs. Marcelo Arnaldo took the part of his wife and her little daughter the part of the farmer's daughter. Faculty Hill children from Forestry and Agriculture acted in the children's scene. They represented healthy children. They looked so healthy and acted so well that instead of taking thirty feet Doctor Russell took a hundred for their scenes. Dr. Antonio Ascalon, the College Physician had the Paris green spraying apparatus ready for demonstration. Scenes were shot of this work. Miss Anne Cole of English Department and Dr. Antonio L. de Leon of Chemistry Department engineered the College preparation for the work. Dr. N.

B. Mendiola of Agronomy Department was on the Experimental Farm and assisted in ararnging the plowing scene.

Doctor Russell expressed his satisfaction with the assistance given and promised that the first public showing of the film would be on the Campus. This film, three reels in length, is to be shown throughout the Islands in an educational compaign against malaria.

Mr. Nicolas L. Galvez, Instructor in Agricultural Chemistry, has returned from Germany where he spent two years in the Institute of Agricultural Chemistry and Soils, University of Göttingen. Mr. Galvez was granted the degree of Ph. D. with major in agricultural chemistry and soils and minor in physics and mathematics. After completing his work in Göttingen, he practiced in the Experiment Station of the Kalisyndikat in Berlin.

Two members of the Agronomy Staff, Messrs. Teofilo Novero and Jose A. Serrano, both Assistants in Agronomy, are retiring as a result of the re-organization of the University. These men have been commended for their efficient work in the department.

The Third National Rural Life Institute was held in the College of Agriculture April 9–14. The chief aim of the Institute is to impart agricultural information to those attending it so that they may become agents of rural progress in their respective communities. The institute is in line with the present movement of developing the natural and agricultural resources of the Philippines. Governor General Murphy, in his message to the Third Rural Life Institute through Dean Gonzalez, wrote in part as follows:

> "It seems to me of special importance this year that the Rural Life Institute should be well and seriously attended. We do not know exactly what is in store for the Philippines in the near future but no matter what befalls, it seems to be certain that these Islands will be more and more thrown upon their own resources economically. The Philippines is essentially an agricultural nation and it will come into its own only when it develops its natural and agricultural resources to the full."

The executive personnel in charge of the institute consisted of Dean B. M. Gonzalez. Dr. N. B. Mendiola, Professor and Head, Department of Agronomy, Director of the Institute; Dr. F. M. Fronda, Secretary of the Institute; and Mr. Jesus de Guzman, Graduate Assistant in Agronomy, Guide.

Some of the subjects presented at the Institute were:

How to raise poultry for profit. By Dr. F. M. Fronda.
Plant propagation. By Dr. L. G. Gonzalez.
Hog raising, curing pork, sausage making. By Dr. M. Mondoñedo.
Vegetable gardening. By Dr. L. G. Gonzalez.
Useful hints in the production of permanent crops. By Dr. Pedro A. David.
Useful hints in the production of annual crops. By Mr. V. B. Aragon.

The delegates were also given the opportunity to consult members of the faculty on the following subjects: General botany and plant nutrition; general crop production; balanced diets of Filipino food; soil types, composition, and management; pests of cultivated plants; diseases of cultivated plants; farm sanitation and engineering; animal raising; farm management, agricultural implements, cost of production of crops; coconut, abaca, coffee, cacao, and other permanent crops; rice, corn, forage, peanut, soybeans and other annual crops; cheese making; raising of flowers and other ornamental plants; agricultural economics; and rural education.

Mr. Mariano Pamintuan, B. S. A. '33 and Mr. Suarez of Angeles, Pampanga, visited the College in May and conferred with some members of the Agronomy faculty about annual and perennial crops.

Technical Bulletin No. 29, "Soil, vegetation and climate" issued by The Imperial Bureau of Science, Rothamsted, England, 1934, lists among "References" and also under "Selected List of Books on General Soil Science," Dr. Robert L. Pendleton's English translation of Dr. E. C. J. Mohr's "Tropical soil-forming processes and development of tropical soils." This translation was issued by this College in mimeograph in 1930. In 1933, it was published by the National Geographical Survey of China, Peiping.

Among the abstracts in *The Madras Agricultural Journal*, January, 1934 is one of the thesis "Amount of residual arsenic on leafy vegetables sprayed with arsenical insecticides" by Juan U. Samson which was published in THE PHILIPPINE AGRICULTURIST, October, 1933.

Twenty-five students took the short course in Plant Propagation in the Summer School. With the exception of one who is a minister, all are teachers from various towns of Laguna, Batangas and Cavite. Miss Corazon Ramos of Batangas was the only woman in the class.

Steps are being taken to make cigarettes out of the White Stem Orinoco tobacco raised in the College tobacco plantation. These cigarettes will be placed on sale in the College Co-operative Store.

A plant of the Java rambutan, the seeds of which Doctor Mendiola brought from Java in 1924 fruited for the first time this summer.

The preliminary results in a study being made in the Agronomy department on the comparative merits of different cultivated bast fibers for sack manufacture show that the fiber hibiscus is more promising than jute.

THE BOOKWORM VANQUISHED[1]

There is a war going on, a war so insidious that most of the inhabitants of this planet are unaware of it, yet of so vital a character that its effects upon posterity may be considered of far greater importance than those of the politico-economic wars that feature the daily news. It is a war of extermination, against the common enemy of mankind, the "Sitodrepa panicea," as it is called in the United States. This is none other than the despised bookworm of the insect, as opposed to the human, variety. The fight to save the literary and artistic treasures of past ages from the destructive activity of these pests has been carried forward for centuries against tremendous odds. The ordinary ravages of time, through climatic conditions, wind and weather, fire and flood, have been mild as compared with the damage created by the lowly worm. The propagation of the species has been so rapid and difficult to check that until only recently librarians have been throwing up their hands in despair. Under favorable conditions the "Sitodrepa manicea," known also as the "drugstore beetle" (which is capable of eating arsenic and lead —in fact, anything except cast iron) will develop from an egg within the short space of two months. Four generations within a year are not unusual, and Houlbert, in his "Les insectes ennemis des livres" (Paris 1903), gives these interesting statistics: "Each female lays about sixty eggs. The following numbers represent the offspring of a single female at the end of a year, presuming that half of each generation is composed of females: first generation, 30; second generation 900; third generation, 27,000, and the fourth generation, 810,000."

It seems odd that, although the vandalism of these pests has continued for centuries, as lately as 1928 no effective remedy had been found. In that year, however, the staff of the Huntington Library at San Marino, Cal., alarmed over the discovery of damage done to some 200 volumes, bestirred themselves and enlisted the aid of the California Institute of Technology. From that time forward the campaign entered a new phase and the warfare became scientific. How thorough were the pains taken with the library's possessions, and how comprehensive the research and experimentation

[1] BROOKS, PHILIP. The New York Times Book Review. January 22, 1933.

which brought ultimate victory to the crusaders, are revealed in the interesting monograph, "Preservation of Rare Books and Manuscripts in the Huntington Library," by Thomas M. Iiams, reprinted for private circulation from The Library Quarterly for October, 1932. Here is part of his story: "By November, 1928, the Huntington Library realized it was fighting a losing battle in using methods advocated by other institutions. At that time we were examining all suspected volumes carefully, dusting and brushing inside the covers as well as the pages, then subjecting the books to a three or four day's treatment of Oronite light solvent in an airtight metal case, and finally sprinkling them throughout with camphor powder and shelving them apart from the main files in a 'convalescing ward,' as it were, to be inspected from time to time for new signs of infestation. In May, 1929, a new generation of beetles made their way into other volumes, and the vicious cycle began all over again."

The solution of the problem consists in vacuum fumigation, by which means almost perfect penetration is obtained without opening every book. The ideal fumigant evolved is a combination of ethylene oxide and carbon dioxide in a liquid that is neither inflammable nor explosive. This fumigant appears on the market now under the trade name of "Carboxide." With the aid of Dr. Irving Gleason, a chemical engineer, there was designed a fumigator five feet in diameter by ten feet long, large enough to accommodate five or six library trucks full of books at one time, or even large pieces of furniture, tapestries and other art objects. The actual operation of the machine is so simple that it does not require the services of a skilled engineer or a fumigating expert. Since the apparatus was installed, all suspected volumes in the rarebook stack have been fumigated, besides any foreign shipments that showed the least signs of infestation. Of course, until the work of fumigating all the books has been completed there is always the possibility of reinfestation, but with the strict vigilance that is being observed it is believed that the battle has been won, and, as far as the Huntington Library is concerned, in the words of Mr. Iiams, it is to be hoped that the " 'diet of worms' will once again be the good earth rather than priceless volumes."

But there is still another phase in the campaign for the preservation of rare books and manuscripts, and that is the struggle against the effects of climate. In "Bureau of Standards Miscellaneous Publications," No. 128 (October, 1931), it was reported that "no library was able to control completely the variation of temperature and relative humidity within the narrow limits considered necessary for

successful preservation of records, and none attempted to minimize acidic pollutions of the air." But the Huntington Library had already made considerable progress in this direction also. Among the destructive agents light, but particularly sunlight, was found to be the cause of "yellowing" and brittling. To correct these evil effects extensive experiments were carried on to determine the calibre of the rays penetrating into the various rooms from both natural and artificial light, and an investigation was made of the advantages of different types of window glass and electric lamps. The result was the installation of actinic glass in the windows on one side of the new reference room and the blocking of those in the main exhibition room. Then there was the problem of dust and acids from the air entering the stacks, and this was successfully solved by means of an air-conditioning plant. In the matter of variations in temperature and humidity, the library has been maintaining for about two years what is now regarded scientifically as ideal conditions, namely a temperature of 70 degrees Fahrenheit and a relative humidity of 50 per cent. Vellum manuscripts that curled and cracked when the humidity was low can now be handled with the comfortable assurance that the gold illuminations will not peel off.

For covers of book the following preservative has been found a satisfactory protection against cockroaches and other insects that eat bindings, evidently for the starch or glue. If put on carefully this preservative does not change the appearance of book covers.

Formula:

Corrosive sublimate	1 ounce
Pure phenol (carbolic acid)	1 ounce
Methlated spirits or good alcohol	1 pint
Liquid shellac	1 ounce

Direction:

With a clean cloth dampened with the preservative rub the binding of books lightly. Do not rub over the lettering, just pat with the cloth.

BUNCHY-TOP OF ABACÁ: ITS NATURE AND CONTROL[1]

G. O. OCFEMIA
Of the Department of Plant Pathology B. P.

WITH SIX TEXT FIGURES

Bunchy-top is a most destructive disease of abacá. It was first known in the Philippines in Silang, Cavite in 1915 but it did not become serious until about 1923. Since that year in many localities in Cavite Province abacá growing has been abandoned and the land planted to rice, corn, coconut, and other crops. And in Paete, Laguna Province bunchy-top is responsible for the destruction of the abacá industry.

Although abacá is very seriously infected by bunchy-top in Laguna and Cavite provinces the disease does not infect Philippine varieties of banana and plantain which are near relatives of this famous fiber plant.

At present, abacá bunchy-top is known definitely in the provinces of Cavite, Laguna, and Davao, all abacá growing regions.

HOW BUNCHY-TOP MAY BE RECOGNIZED

Early stage of the disease

On the leaves. The first symptom of abacá bunchy-top is the presence of yellowish white and indefinite pale green or yellowish green areas on the blade of the youngest open leaf. These areas are clearly shown on the margins and blade of the youngest leaf (fig. 1b). When a leaf which shows the first symptoms is fully expanded the green portions of the blade on either side of the midrib are darker green than on a leaf of a healthy plant. The pale green areas are thinner than the rest of the blade and are often retarded in their growth. As a result, the leaves curl upwards or tear along the margin. Delicate transparent membrane-like areas of varying sizes may be formed on the thin pale green or yellowish green portions of the youngest leaf either before it opens or immediately after

[1] Experiment Station contribution No. 963. Circular 27. This circular is a revision of and supersedes the writer's article in 1931 entitled "The bunchy-top of abacá and its control." The Philippine Agriculturist 20: 328–340. *Fig. 1–6.*

Received for publication January 11, 1934.

(fig. 1c). If held in the light the main veins of the leaves showing the symptoms appear as transparent lines continuous from the midrib to the margin. They are about one-half of a millimeter in width. On the secondary veins these lines are broken into parts one- to five-millimeters in length. On both surfaces of the leaves these parts appear yellow. If the leaf is still rolled the transparent lines appear

Fig. 1.—(*a*) A leaf of a healthy abacá plant fully expanded. (*b*) A leaf of a diseased abacá plant of the same age as the healthy plant from which (*a*) was taken. The leaf (*b*) shows the yellowish white and indefinite chlorotic areas on the blade, and it is curling and tearing along the margin. (*b'*) Another leaf showing the curling along the margin as compared with the fully expanded leaf (*a*) from a healthy plant. (*c*) A young leaf of abacá, C. A. 4293 Itom, affected with bunchy-top from aphid-transmission experiment on August 17, 1926, showing the membrane-like areas (×) along the margin of the leaf. The membrane-like tissues on the upper part of the leaf were torn off.

(All photographs except fig. 1c, by the Photographic Division, Soils Department, College of Agriculture. Fig. 1c, from photograph by the Bureau of Science, Manila).

water-soaked. In some varieties of abacá, dark green streaks which vary from mere dots to lines several millimeters long may be seen (fig. 2b). The long streaks may start from the midrib and disappear

as they reach the borders of the pale green or yellowish green areas of the infected leaves. These dark green lines are also about one-half of a millimeter wide. They are occasionally present on the midrib, petiole, and leaf blades. Frequently, these dark green streaks may be seen on the plant only in the more advanced stage of the disease.

The leaf which shows the first symptom of the disease is usually shorter and narrower than the leaves which were produced before the plant was attacked. The narrowing of the leaf blades sometimes continues down to within a few centimeters of the midrib. Owing, perhaps, to its narrowness the leaves of diseased plants open much more readily than the leaves of healthy plants. Furthermore, the leaves of diseased plants have a tendency to curl up along their margin and they are stiffer than the leaves of healthy abacá.

On the false stem. The green portions of the leaf sheaths of infected plants are darker in color than the green portions in healthy abacá. When an abacá plant is infected the growth of the new or innermost leaf sheath is retarded and it becomes as short as or shorter than the one next to it (fig. 3 and 4). As the disease advances the petioles begin to arise from nearly the same level at the upper end of the false stem, and as a result the leaves are borne in a more or less rosette arrangement (fig. 3 and 5b, b′). It is probably the production of leaves in the rosette arrangement that gave the disease the name "bunchy-top."

On the roots. In the early stage of bunchy-top the root systems are not affected. They are the same in extent and in color as the roots of the healthy abacá plants.

Advanced stage of the disease

On the leaves. As the disease advances the new leaves produced are stiff and become progressively narrower and shorter than the one immediately below. In healthy abacá plants, until the plants begin to flower, the expanded youngest leaf is longer and wider than the leaf next to it. In an advanced stage of bunchy-top the leaves of abacá are malformed and in many cases even aborted. They are much reduced in size and curled upwards along the margin. The margins are almost white and the pale green or yellowish green color extends towards the midrib in the form of irregular diffuse streaks with their long axes parallel with the veins.

In some cases of bunchy-top infection of abacá the thin almost white areas along the margin of the leaf turn brown and die starting from the edge (fig. 4) or from any of the thin transparent membrane-like patches (fig. 1c). The death and browning of the leaf blades sometimes continue until the midrib is reached. Often the dead thin

almost white portions involve the entire length of the youngest rolled leaf. During the wet season the dead tissues rot and sometimes this rotting continues downwards producing what is called heart-rot. Under favorable conditions the rotting of the central cylinder may extend as far as the corm. In fields of abacá seriously infected with bunchy-top from 11 to 17 per cent of the diseased plants finally die of heart-rot.

On the false stem. As the youngest leaf sheaths are shorter than the outer older ones the false stems of diseased abacá are much shorter than those of healthy plants of the same age. The girth at the top of the false stem of diseased plants may be the same as, or

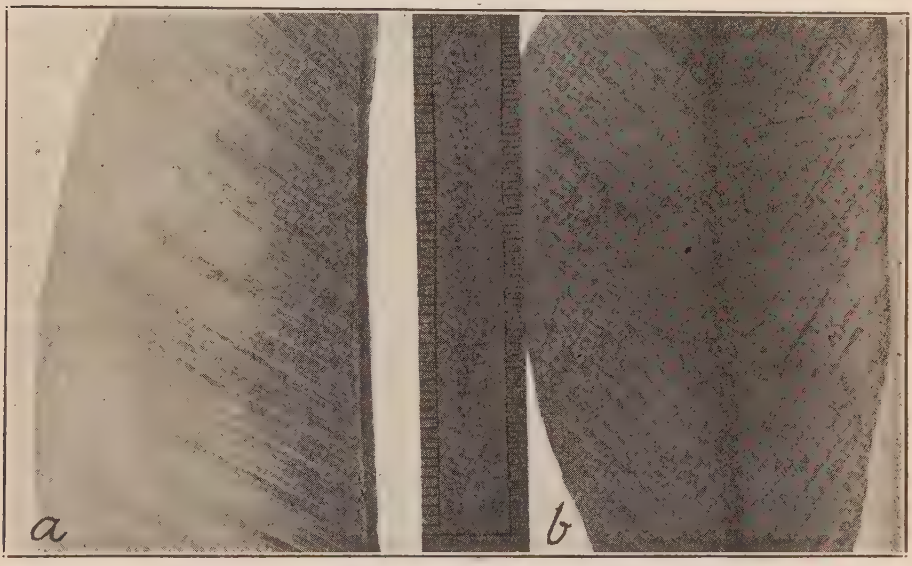


Fig. 2.—Back view of small portions of the leaves of (*a*) healthy and (*b*) a diseased abacá, variety Inosa photographed in transmitted light on February 6, 1928. Note the dark green streaks between the veins of the leaf in (*b*). The specimens were collected from suckers of infected stools which were more than two years old. The plant was infected in an experiment on aphid-transmission of bunchy-top conducted in November, 1925.

greater than, that at the base. This is because the shortening of the inner leaf sheaths forces the bases of the petioles outwards. In healthy abacá plants the false stems are long, and they taper gracefully towards the upper end because the petioles are set farther apart than in the diseased plants and the youngest leaf sheath is the longest (fig. 5a).

Infected abacá plants may remain alive for more than two years but they gradually become smaller and smaller until finally all of the

leaves and leaf sheaths turn brown and die. As a rule abacá plants infected with bunchy-top do not fruit.

On the roots. In the advanced stage of the disease the roots of the infected abacá plants gradually turn dark-colored, die and rot. Various fungi and bacteria may be found in the rotting roots. In advanced stages of bunchy-top the death of the roots is from starvation, the result, perhaps, of the inability of the diseased plant to furnish them with sufficient organic foods. The rotting of the roots is a result rather than a cause of bunchy-top.

Abacá plants attacked by bunchy-top are stimulated to produce numerous undersized suckers. These suckers have small and stiff leaves with curled up margins. On the leaves of the suckers the characteristic symptoms of bunchy-top and the almost white areas are much more pronounced than on the leaves of plants which were infected from outside sources.

THE CAUSE OF BUNCHY-TOP AND SPREAD OF THE DISEASE

Bunchy-top of abacá is a virus disease. When a plant disease is caused by virus the juice of the plant contains some unidentified infective principle which is capable of passing through filters that remove fungi and bacteria. Diseases caused by virus are usually identified by the symptoms and effects that they produce on the plants.

In bunchy-top of abacá the very small amount of the juice which five adult plant lice can draw out from diseased plants and inject into healthy plants will cause the disease in 28 days on abacá seedlings which have false-stems 30 centimeters long. In 28 days the virus will be found in the sap taken from any part of the plant, showing that the infective principle is living and multiplying. For the reason that the virus may be obtained from any part of the plant, diseases like abacá bunchy-top, are also called systemic diseases.

The virus that causes the bunchy-top disease of abacá in the Philippines is restricted to abacá, it does not infect banana or plantain. This virus cannot be transmitted by knife cuts, needle pricks, injection with hypodermic syringe, through soil or other mechanical means as can the virus of the mosaics of tobacco, cucumber, sugar cane, etc. The virus of abacá bunchy-top is transmitted from diseased abacá to healthy abacá only by the brown plant louse or aphid known in science as *Pentalonia nigronervosa* Coq. These aphids that is found feeding on banana, abacá and camia. This louse is

Fig. 3.—A typical bunchy-topped abacá showing the curling of the leaves along the margin and the bunching and rosette arrangement of the leaves. Note that the diameter of the false stem at the base and just below the petioles are about the same. Note further that the petioles arise from the same plane. The specimen was collected from the abacá field of the Department of Agronomy of the College of Agriculture at Los Baños and photographed on January 16, 1926.

feed all over the plant. Most of them are found at the bases of the petioles, on the tightly rolled youngest leaf and at the base of the false-stems. If about 20 aphids are allowed to feed on a diseased abacá plant for 12 hours and then these are transferred to a healthy abacá plant and allowed to feed on this for 48 hours bunchy-top is transmitted. The appearance of the youngest rolled leaf of abacá infested with this aphid, or plant louse is shown in figure 6.

The aphids are spread in the field in two ways. Those that have wings, though not capable of prolonged flight, may be carried to plants at some distance by the wind. And ants also are very important agents in spreading the aphids.

Although the young aphids are born alive the virus in the body of the mother aphid is not transmitted to the young to which she gives birth. This fact is of importance in the control of the disease. As soon as the aphids which had fed on diseased plants are dead, offspring are harmless as agents in spreading the virus of the bunchy-top. The only danger is the diseased plants from which the young aphids can obtain the virus.

HOW BUNCHY-TOP MAY BE CONTROLLED

Prevent bunchy-top from spreading

Bunchy-top can be kept from destroying the abacá industry of the Philippines if each planter will do his share in the control of this most destructive disease of abacá. Effort should be exerted to prevent the plant louse which carries the virus that causes bunchy-top from spreading it from locality to locality. Not only should individual abacá planters make every effort to keep the disease from spreading from one abacá district to another or from plantation to plantation but groups of planters should combine to keep the disease out of their locality.

One way to prevent the spreading of the disease is by prohibiting the movement from the infected areas to other abacá localities of all abacá, banana and camia or parts of them, with the exception of the clean fiber of abacá, banana, canton, and pacol. For, thus far the transmitting aphid has been found only on abacá, banana and camia. It is important also to prohibit the moving from a bunchy-top infected locality of the soil taken from abacá or banana fields as well as the suckers and corms of abacá, banana, and camia. The use of leaf sheaths of banana and leaves of abacá and banana for wrapping propagating plant materials and perishable products for shipment from the bunchy-top-infected regions to the abacá-growing

Fig. 4.—An advanced stage of bunchy-top infection of abacá showing the even diameter of the false stem from the base to the upper end, the crowding of the leaves, and the plane from which the petioles arise. Note that the margins of the inner leaves are dead and rotting and dark colored. The specimen was collected from the abacá field of the Department of Agronomy and photographed on January 16, 1926.

districts known to be free from the disease is extremely dangerous. In dry weather and immediately after heavy rains the plant louse or aphid may be found on the corms, among the roots, at the bases of plants, between leaf sheaths and in the honeycomb-like chambers at the cut ends of the petioles and leaf sheaths of abacá and banana. Obviously, in an infected area these aphids would be virus carriers.

Destroy the diseased plants and the plant louse

Should bunchy-top find its way into an abacá province, locality or plantation in spite of the precautions to keep it out, it is most important on discovery of the first symptom that the entire stool be dug up at once, chopped in pieces at place of digging and sprayed with ordinary soap solution. The soap solution may be prepared by dissolving one-half kilogram (500 grams) of fish-oil soap in 12 to 20 liters of water. If no fish-oil soap is available, common laundry soap may be substituted.

The soil around the stools should also be sprayed in order to kill the aphids which are in the ground. Also, all bananas and camia should be thoroughly sprayed, because the plant louse from the diseased abacá may move to these plants. If a regular spray pump for applying the spray cannot be obtained a "flit" pump may be used with satisfactory results.

After spraying the chopped pieces of the diseased abacá plants and the soil around them, the corms of the infected plants should be put on a pile of dry trash and burned until they are cooked, they will not then sprout and furnish infectious materials for the aphids. This measure is recommended in a locality where the disease is of recent introduction as a way to prevent its spread over the whole plantation; also, in new plantings in totally devastated fields like those in Laguna and Cavite provinces where farmers are contemplating reviving the abacá industry.

Resistance to bunchy-top

The bunchy-top of abacá in the Philippines infects only abacá. At the present time it is not known whether eventually, varieties of abacá which are highly resistant to the disease may be developed. In the writer's work at Los Baños all the varieties of abacá used are infected by bunchy-top in the same degree. He used plants from suckers, plants grown from seeds and first generation variety hybrids. There seems to be very little hope of developing resistant forms of abacá by selection. Occasionally, some abacá plants infected with bunchy-top recover. These plants, however, are not

resistant to the disease. They are just as susceptible to bunchy-top as they were before they were first infected. Crossing abacá with other species like banana, saguing matsing, pacol and canton may yield resistant hybrids. This crossing, however, may reduce the quality of the fiber produced. The use of fertilizers in an effort to produce resistant strains or plants is useless, for the more luxuriant the abacá plants are the more susceptible to infection they become.

Fig. 5.—(*a*) A healthy abacá plant showing the graceful tapering of the false stem from the base to the tip. It also shows that the leaves are progressively longer and wider and are arranged further apart. (*b*) The rosette arrangement of the leaves of two infected abacá suckers as seen from above. (*b'*) An affected abacá plant of the same age as that in (*a*) showing the crowding of the leaves, the shortened false stem, and the curling of the leaves along the margins.

REPLANTING ABACÁ FIELDS

The abacá fields in the completely devastated areas of Cavite and Laguna provinces can be replanted and made as productive as before the bunchy-top destroyed the plants. In this work all sus-

pected abacá plants must first be completely eradicated, or removed, and the land rested for nine to twelve months. No corm of an infected abacá plant should be allowed to produce new shoots, if the plant louse is present these shoots would be a source of the virus for it. The best way to prevent the old corms from producing shoots is to pile them on top of dry wood, dry abacá leaves or dry weeds and burn them. It is not necessary to burn the old corms to ashes. All that is needed is to produce sufficient heat to cook the corms so that they will not sprout. After the period of rest of the field the old hills can be replanted with healthy suckers taken from regions known to be free from bunchy-top, or by plants grown from seeds. Occasional infection of replaced abacá plants is due to inability to recognize the presence of the aphid which had fed on a diseased plant and carried the infectious material from diseased to healthy abacá plants.

The infectious material of bunchy-top is drawn from the plant by the aphid with the sap of the abacá on which it feeds. This infectious material, however, is not transmitted to the young which are born of the infected adult aphids. With this knowledge there is considerable assurance that as soon as the infected parent aphids are dead there is no fear of their young causing infection. The only sources of infectious material for the young aphids are diseased abacá plants and young tender shoots from the corms of diseased abacá.

This is the reason that plants which are to be used in replanting old abacá fields should be started either from seeds or from suckers obtained from districts absolutely free from bunchy-top. Although abacá grown from seed requires a longer period to reach maturity and productiveness then when grown from suckers, it is easier to transport and handle and it eliminates the chance of obtaining plants with latent or dormant stages of bunchy-top and thus prevents the introduction of the plant louse through planting material. With either planting material, during the first few months, the young plantings should be carefully inspected at intervals of 30 to 40 days. Every part of each plant should be looked over. Any bunchy-top case found should be dug up at once, chopped in pieces in place of growth and sprayed with soap solution and the corm burned to prevent it from sprouting. The effectiveness of the eradication of the disease in the new plantings and the success of the replanting work depends upon one's ability to diagnose or determine accurately the early symptoms of bunchy-top of abacá. All aphid-infested plants, and the ground immediately about them, should be sprayed with soap solution and these plants should be watched with special suspicion.

Fig. 6.—A young furled leaf of an abacá sucker (about 30 cm. from the soil to the base of the petiole of the next youngest leaf) showing a large number of the aphids, *Pentalonia nigronervosa* Coq. The plant from which this specimen was taken was infected with bunchy-top. The specimen was collected from the abacá field of the Department of Agronomy and photographed on November 21, 1925. (About natural size.)

SUMMARY

1. Bunchy-top is the most destructive disease of abacá known.

2. The disease is first shown by whitish indefinite streaks on the blades of the rolled youngest leaves. This is followed by the curling of the margin of the expanded leaves and then by the bunching of the petioles on the upper part of the false stem. The false stem does not increase in length, and the diameter at the upper end may be the same as the diameter at the base. At first, the roots do not show any effect from bunchy-top but as the disease advances the roots rot. Infected plants become smaller and smaller until they finally die after about two years. In advanced cases of the disease from 11 to 17 per cent of the plants die of heart-rot.

3. Bunchy-top is caused by a virus which is spread from plant to plant by the brown plant louse, or aphid *Pentalonia nigronervosa* Coq.

4. The disease may be prevented from destroying the abacá industry in a region by prohibiting the movement of abacá, banana, and camia or parts of these plants and of soil from infected areas, districts or plantations to localities or plantations known to be free from the disease.

5. If the disease breaks out in a locality or plantation it should be exterminated at once, and the remaining plants protected from infection.

6. Up to the present time no varieties of abacá are known to be resistant to bunchy-top.

7. Abacá fields that have been completely destroyed by bunchy-top can be replanted if directions as given in this paper are followed.

LITERATURE CITED

OCFEMIA, G. O. 1926. Progress report on bunchy-top of abacá, or Manila hemp. Phytopathology 16: 894.

OCFEMIA, G. O. 1927. Second progress report on bunchy-top of abacá, or Manila hemp. Phytopathology 17: 255–257. *Fig. 1.*

OCFEMIA, G. O. 1930. Bunchy-top of abacá, or Manila hemp: I. A study of the cause of the disease and its method of transmission. Amer. Jour. Bot. 17: 1–18. *Pl. I–IV.*

OCFEMIA, G. O., AND GABINO G. BUHAY. 1934. Bunchy-top of abacá, or Manila hemp: II. Further studies on the transmission of the disease and a trial planting of abacá seedlings on a bunchy-top devastated field. The Philippine Agriculturist 22: 567–581. *Fig. 1, 2.*

STUDIES ON THE PHYSICAL QUALITIES OF THE HEN'S EGG: I. OBSERVATIONS ON NEW-LAID LOS BAÑOS CANTONESE EGGS [1]

F. M. FRONDA AND D. D. CLEMENTE

WITH ONE TEXT FIGURE

Eggs are a very important commercial product of the poultry industry, but they are highly perishable commodities. The shell of the egg is not only very fragile but it is also porous. Because of this porosity, the contents of the egg change in accordance with the length of time that it is held and with the environment, and the tendency is for its value to decrease every day after it is laid (Brown, 1929). The "condition of shell and contents of eggs which can be marketed in such a manner as to give the greatest satisfaction to the consumer is spoken of as quality" (Jull, 1930).

The observations made on new-laid eggs, the results of which are herein reported, form the first of a series of studies that are being made along this line in this College. These studies were conducted to provide a basis upon which comparisons may be made. As the physical condition of new-laid eggs in the Philippines had never been studied before, the results obtained from the present studies should be of timely interest, not only to the producer but to the consumer as well. These observations were made in the Poultry Laboratory of the Department of Animal Husbandry, College of Agriculture, in August, 1933. To what extent the results obtained in this study may be applicable to eggs laid during the other months of the year will be the subject of the second paper in this series.

Materials used. In these observations, one hundred new-laid Los Baños Cantonese eggs were used. It was decided to use the eggs of this breed because of the popularity of the Los Baños Cantonese chicken throughout the Islands. Whether the results obtained from these studies will be applicable or not to the eggs of the other breeds of chickens now available in this country will have to be determined later.

The eggs were laid by the Los Baños Cantonese flocks of the College of Agriculture. The layers that produced these eggs were

[1] Part of the expenses incurred in this study were paid from a research grant by the Philippine Poultry Association. Experiment Station contribution No. 964. Received for publication January 15, 1934.

all given the same ration, the College laying ration, and the eggs were gathered from the nests soon after they were laid. No attempt was made to select these eggs. They were observed within the first 24 hours after they were laid.

The following qualities in the eggs were studied: (*a*) texture and color of the shell; (*b*) weight of the egg; (*c*) volume of the egg; (*d*) specific gravity of the egg; (*e*) angle of inclination of the egg when submerged in water; (*f*) height and diameter of the air cell; (*g*) color of the yolk; (*i*) strength of the yolk; (*j*) size of the germ; and (*k*) quality of the albumen. How these different characteristics were studied are discussed separately in the following pages under "Results and Discussions."

RESULTS AND DISCUSSIONS

Texture and color of the shell. The texture of the shell was graded into good, medium and poor and the color into brown, light-brown and tinted. Although no exact standards were used in distributing the eggs into these different grades, it may be stated that these classifications were accurate enough for practical purposes. Three representative eggs, one with good shell, one with medium and one with poor were set aside and the others were compared with these. A similar procedure was followed in studying the color of the shells.

Following these classifications, the results of the observations made were: Out of the 100 eggs studied, 66 had shells of excellent texture, 21 had medium and only 13 had rather poor shells. And of the 100 eggs observed, 25 had brown shells, 54 had light-brown and 21 had tinted. Tinted shells were too light to be called light-brown, but they were not white enough to be classed as white eggs, such as those produced by White Leghorn chickens.

A close observation of the shells of the new-laid Los Baños Cantonese eggs studied showed that these were covered with whitish powdery particles known as the cuticle. The 100 new-laid Los Baños Cantonese eggs that were examined did not show any visible pores on the shells. Dunn (1923) stated that new-laid eggs with visible pores were laid by particular hens.

Weight of the eggs. The eggs studied were weighed individually in an analytical balance and the weights were recorded to the hundredth of a gram. The individual weights ranged from 34.78 to 58.31 grams. Of the eggs observed, 30 per cent weighed less than 40 grams each, 62 per cent weighed from 40 to 49 grams each and 8 per cent from 50 to 59 grams each. The mean weight of these eggs was 43.23 $\pm$ 0.3057 grams, and the mode was 45.00 grams.

Volume of the egg. Not having the device for determining the specific gravity of eggs, which is on the market, and is described by Mussehl and Halbersleben (1923), the specific gravity of the eggs studied was obtained by dividing the weight by the volume. Hence, the volume of each egg was determined after finding its weight. The volume was obtained by water displacement, and for this purpose, a set of apparatus was constructed. The apparatus was composed of a burette with an iron stand, a funnel inserted at the mouth

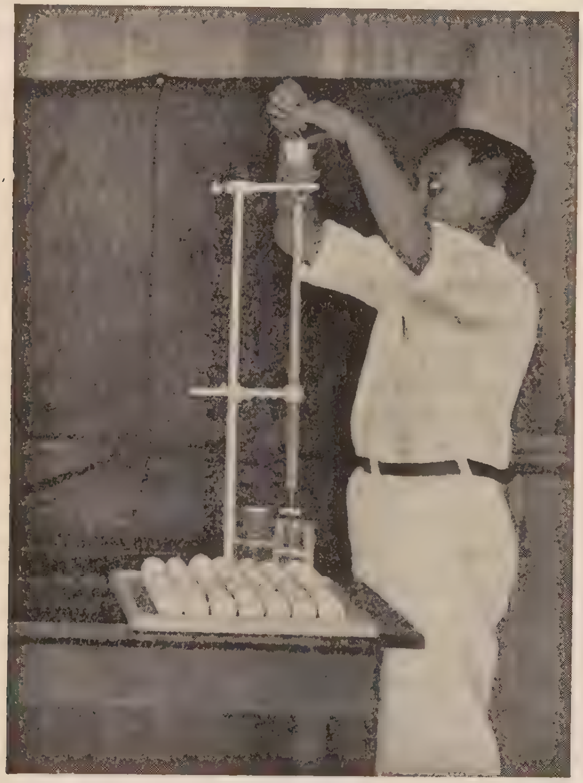


Fig. 1.—Determining the volume of an egg.

of the burette, a 100 cc. beaker placed on the top of the funnel and a wire loop, this loop forming an angle of a little less than 90° with that of its handle (see fig. 1).

In the determination of the volume of the egg, the following procedure was followed: The beaker was filled with water with the wire loop inside. The egg to be studied was moistened and then partly dried by gently shaking it once or twice. The wire loop was raised with one hand from the beaker filled with water and with

the other the egg was placed with the butt uppermost on the loop. The loop was then lowered slowly to the bottom of the beaker. The volume of the water displaced by the egg corresponds to the volume of the egg.

The volume of an egg was determined twice only if the two determinations were about the same. But if the measurements varied more than 0.5 cc., the volume of the egg was measured three or four times and the average of all the determinations was used. In most cases, however, the differences did not exceed 0.1 cc. The volume of an egg was determined as close as possible to the tenth of a cubic centimeter.

To find the approximate accuracy of this method, the volumes of two eggs were each determined 10 times. When the readings taken were treated statistically, one of the eggs was found to have an average volume of 45.34 $\pm$ 0.0539 cc. with a standard deviation of 0.2277 $\pm$ 0.0343. The volume of the other egg averaged 49.45 $\pm$ 0.0710 cc. with a standard deviation of 0.3170 $\pm$ 0.0478. These variations show that this method is accurate only to about one-fourth of a cubic centimeter.

One of the sources of error in the use of this method lies in unequal wetting of the eggs, because eggs differ in area of shell surface. Another source of error may be in the lowering of the egg into the beaker. A slight trembling of the hand holding the loop when the egg is under the water will cause an extra overflow. Unequal cleaning of the apparatus at different times may be another source of error. Extreme care was taken, however, to keep all errors as low as possible in these determinations.

By following this method, it was observed that the individual volume of the new-laid 100 Los Baños Cantonese eggs varied from 33.4 to 55.6 cc. with a mean of 41.1 $\pm$ 0.3055 cc. and a standard deviation of 4.529 $\pm$ 0.2160. With this information available, the individual specific gravity of the eggs studied was easily determined by dividing the weight by the volume.

Specific gravity of the egg. The specific gravity of each of the 100 new-laid Los Baños Cantonese eggs was determined. The variation was from 1.029 to 1.0770. The mean specific gravity of these eggs was 1.056 $\pm$ 0.0098 with a standard deviation of 0.1457 $\pm$ 0.0007. Mussehl and Halbersleben (1923) reported that the specific gravity of the 958 eggs that they studied was 1.07. Unfortunately, the kind of eggs studied was not stated in the report. These investigators, however, stated that "variations in the thickness of the shell are more likely to influence the specific gravity of eggs than are variations in protein or fat content."

Angle of inclination of the egg when submerged in water. That fresh eggs will sink in water is common knowledge. Fronda (1928) stated that fresh eggs will sink in water and lie nearly flat on the side in the bottom of the dish; the older or stale ones may sink but will stand up on the small end; and very stale ones will tend to rise to the surface of the water.

Observations were made on new-laid eggs in order to determine how flat they will lie on the bottom of the vessel. For practical purposes, ordinary clear pipe water was used. The centers of the butt and of the tip of the egg were marked. With these two points as guides to denote the terminals of an imaginary line passing through the longitudinal axis of the egg and with a protractor the angle of inclination of the egg was measured.

Observations made on the angle of inclination of 100 new-laid Los Baños Cantonese eggs showed that this varied from 6 to 19 degrees, with 10.5 degrees as the mode. The mean angle of inclination of the 100 eggs studied was 10.84 ± 0.1810 degrees. In all cases, the butt of the egg was raised a little higher than the tip. This result was expected for the butt of the egg contains the air cell, hence the tendency is for it to be slightly lighter than the tip. Besides this, it is a matter of common observation that the shell at the butt is thinner than that of the tip.

Height and diameter of the air cell. After the eggs were weighed, they were candled. Through the candler, the white appeared dense and the movements of the yolk could hardly be seen. The albumen and the yolk seemed to be salmon buff color; the yolk was a little the darker. The air cell was very small.

To get the size of the air cell accurately, it was marked with a pencil and measured with the use of a caliper. In this study, only 98 eggs were used as two eggs were discarded because one had a movable air cell and the other an abnormally large air cell. The height of the air cell in the 98 eggs studied ranged from 0.10 to 0.19 centimeter, with a mode of 0.14 centimeter and a mean of 0.140 ± 0.0012 centimeter. These had a mean diameter of 1.323 ± 0.0081 centimeters. The diameter of the air cell varied from 1.12 to 1.63 centimeters, with a mode of 1.22 centimeters. One of the eggs that was discarded had an air cell that was 0.32 centimeter high and 2.08 centimeters wide. At present the writers can give no explanation of this abnormality in this new-laid egg. Pennington, Jenkins and Betts (1918) reported that fresh eggs had air cells that are about three-fourths of an inch or 1.94 centimeters in diameter.

In this connection, it may be mentioned that the height of the eggs studied varied from 4.61 to 5.85 centimeters, with a mean of 5.21 ± 0.0677 centimeters. When the height of the air cell was divided by the height of the egg and the result multiplied by 100, the resulting figure is the "air cell height—egg height percentage." It was observed that this varied from 2.00 to 3.91 per cent, with a mean of 2.668 ± 0.0238 per cent and a standard deviation of 0.3498 ± 0.0167. When the height of the egg was correlated with the height of the air cell, the correlation obtained was only 0.345 ± 0.0600. Although small, the correlation was significant.

The mean diameter of the 100 eggs studied was 3.87 ± 0.0094 centimeters with a standard deviation of 0.138 ± 0.0066. When the diameter of the air cell was similarly divided by the diameter of the egg and the result multiplied by 100, the "air cell diameter—egg diameter percentage" obtained varied from 28.0 to 41.4. The mean was 34.11 ± 0.1804 per cent and the standard deviation was 2.663 ± 0.1283. The correlation between the diameter of the egg and the diameter of the air cell was 0.467 ± 0.0535, also a significant correlation.

The "air cell index" was obtained by dividing the height of the air cell by its diameter. It was observed that in the 100 new-laid Los Baños Cantonese eggs studied, the individual air cell index ranged from 0.087 to 0.1257. The mean air cell index was observed to be 0.108 ± 0.0006 with a standard deviation of 0.0096 ± 0.0005. While the value of these different figures may not now be apparent, they may be found useful in comparing new-laid with stale eggs, which will be the subject of a subsequent paper in this series.

Color of yolk. After the eggs had been examined externally, they were broken one by one and the contents studied in a Petri dish. In all cases, the yolks of the 100 new-laid Los Baños Cantonese eggs studied were upstanding and floating on a firm stand of albumen. The yolk color was classified into three groups; namely, pale-yellow, rich yellow and deep yellow. It was observed that twenty-six per cent of the yolks were of pale-yellow color, fifty-six, rich yellow, and eighteen per cent were deep yellow. Variations in yolk color, however, may be due to individuality of the birds, and to the kind of feeds that the birds receive. For instance, there are breeds of chickens that naturally produce deep-yellow yolks and there are others that lay eggs that have light-yellow yolks. The Los Baños Cantonese fowl may be said to produce rich yellow yolks.

Diameter and thickness of the yolk. Sharp and Powell (1930) used what they call the "yolk index" as a means of determining

the quality of an egg. The yolk index is obtained by dividing the height of the yolk by its width. According to their observations, the average yolk index of fresh eggs, possibly White Leghorn eggs, was 0.411. Stewart, Gans and Sharp (1932), however, found that the average yolk index of 578 newly laid eggs was 0.409.

Observations made on the 100 new-laid Los Baños Cantonese eggs showed that the height of the yolk varied from 1.54 to 2.21 centimeters with a mean of 1.864 ± 0.0117 centimeters and a standard deviation of 0.173 ± 0.0082. The diameter of the yolks of these eggs ranged from 3.56 to 4.55 centimeters, with a mean of 3.957 ± 0.0141 centimeters, and a standard deviation of 0.209 ± 0.0100. The yolk index varied from 0.389 to 0.569, with a mean of 0.472 ± 0.0027 centimeter and a standard deviation of 0.0399 ± 0.0019.

It will be noted that the yolk index obtained in this study is higher than that reported by Sharp and Powell (1930) and by Stewart, Gans and Sharp (1932). It is possible that the difference in the size of the eggs used in this study and the eggs used by these investigators may partly account for the differences in the yolk indices, for Stewart, Gans and Sharp (1932) observed that eggs that are small in size had higher yolk indices than larger eggs, all other conditions being equal. It is also possible that such a difference may be due to the difference in the methods used in measuring the height and width of the yolk. Sharp and Powell (1930) and Stewart, Gans and Sharp (1932) measured the yolk with the albumen, separated, while in this study, the height and width of the yolk were measured without removing the albumen. Again, there may be actual differences in the yolk indices of eggs of different breeds. Further studies will be necessary to determine the influence of these different factors on the yolk index of the egg.

Strength of the yolk. The strength of the yolk is also commonly used as an index of egg quality. Peters (1931) suggested that a practical way of determining the strength of the yolk is by transferring it from palm to palm of the hands. He said that if the yolk can be transferred from palm to palm for 40 to 50 times or more without breaking, the egg is of good quality. Using this suggestion as a method in the study of the strength of the yolk of the 100 new-laid Los Baños Cantonese eggs, it was observed that the yolks of these eggs were fairly strong. Of the 100 new-laid eggs studied, only twenty-six had yolks that could not be transferred from palm to palm more than forty times. The yolks of the other seventy-four eggs could be transferred from palm to palm from 41 to 220 times, with a mode between 120 and 139.

Size of the germ. Of the 100 new-laid Los Baños Cantonese eggs, only 65 were found to be fertile. Benjamin (1923) in describing new-laid fertile eggs stated that, "The central light-colored area of a germinal disk of a fertile egg had a definite circular boundary. The dark ring around the germinal disk may not be conspicuous. The boundary of the central light-colored area of the germinal disk of an infertile egg is indefinite and irregular. Dark rings are sometimes noticeable around the infertile germinal disk, but they are not usually quite so conspicuous as those around the fertile eggs."

The size of the germ in new-laid fertile eggs varies, owing to the difference in the length of time that the eggs are held inside the different hens that lay them and to the time of the day when the eggs are laid. The size of the germ of the 65 new-laid Los Baños Cantonese eggs observed varied from 0.50 to 0.76 centimeter, with an average of 0.67 centimeter.

Character of the albumen. The density of the albumen was graded into thick, medium and watery. Of the 100 new-laid Los Baños Cantonese eggs examined, only 10 had a rather watery albumen, 38 had medium and 52 had thick albumen. In general, it may be said that the white of the 100 new-laid Los Baños Cantonese eggs was very thick. The thin white was very little in comparison to the thick. Six of the eggs examined had a greenish tinge in the albumen but the albumen of the rest was normal. Only two eggs were observed to have meat spots. These may have been "abnormal growths of tissue that frequently develop in the oviduct and are later dislodged when an egg passes through." (Benjamin, 1923.) No egg was observed to contain blood clots.

SUMMARY AND CONCLUSIONS

The results of observations on 100 new-laid Los Baños Cantonese eggs may be summarized as follows:

1. The shell has on its outer surface little powdery particles of whitish material, the cuticle.

2. The shell is of good texture and has no visible pores.

3. The individual weight of the 100 new-laid Los Baños Cantonese eggs observed ranged from 34.78 to 58.31 grams, with a mean of 43.23 ± 0.3057 grams.

4. The individual volume of the 100 new-laid Los Baños Cantonese eggs observed varied from 33.4 to 55.6 cu. cm. with a mean of 41.1 ± 0.3055 cu. cm.

5. The specific gravity of a new-laid Los Baños Cantonese egg is 1.056 ± 0.0098.

6. When placed in a vessel of clean pipe water, the egg lies almost flat on its side with the butt tilted up a little. The angle of inclination is 10.84 ± 0.1810 degrees.

7. When candled, the albumen and the yolk seem to have the same salmon buff color, the yolk being a little the darker.

8. The yolk is immobile or only slightly mobile.

9. The air cell is small and it has a mean height of 0.140 ± 0.0012 centimeter and a mean diameter of 1.323 ± 0.0081 centimeters.

10. The "air cell height-egg height percentage" of a new-laid Los Baños Cantonese egg is 2.668 ± 0.0238.

11. The "air cell diameter-egg diameter percentage" of a new-laid Los Baños Cantonese egg is 34.11 ± 0.1804.

12. The "air cell index" of a new-laid Los Baños Cantonese egg is 0.108 ± 0.0006.

13. The yolk is upstanding and floats on a firm stand of albumen. The yolk is rich yellow in color.

14. The mean height of the yolk is 1.864 ± 0.0117 centimeters and the mean diameter is 3.957 ± 0.0141 centimeters.

15. The yolk index varies from 0.389 to 0.569 with a mean of 0.472 ± 0.0027.

16. The size of the germ of new-laid fertile Los Baños Cantonese eggs varies from 0.50 to 0.76 centimeter with an average of 0.67 centimeter.

17. New-laid Los Baños Cantonese eggs have albumen of excellent quality. Compared with the thick white the thin white is very little.

LITERATURE CITED

BENJAMIN, EARL W. 1923. Marketing poultry products. vii + 328 p., 132 fig. New York: John Wiley & Sons, Inc.

BROWN, EDWARD. 1929. Poultry breeding and production. 2 vols. xv + 864 p., pl. 1–104. New York: John Wiley & Sons, Inc.

DUNN, L. C. 1923. I. The variation of eggs in the rate at which they lose weight. Poultry Science **2**: 45–58.

FRONDA, F. M. 1928. Poultry raising. xviii + 261 p., 61 fig. Manila: Oriental Commercial Company, Inc.

JULL, MORLEY A. 1930. Poultry husbandry. ix + 639 p., 229 fig. New York: McGraw-Hill Book Company, Inc.

MUSSEHL, F. E., AND D. L. HALBERSLEBEN. 1923. Influence of the specific gravity of hens' eggs on fertility, hatching power, and growth of chicks. Jour. Agric. Res. 23: 717–720.

PENNINGTON, M. E., M. K. JENKINS, AND H. M. P. BETTS. 1918. How to candle eggs. U. S. Dept. Agric. Bull. 565: 1–20. *Fig. 1; pl. 1–20.*

PETERS, A. A. 1931. Breaking eggs to increase poultry profits. Poultry Craftsman and the Pacific Poultryman 46: p. 50, December.

SHARP, PAUL F., AND C. K. POWELL. 1930. Decrease in interior quality of hen eggs during storage as indicated by the yolk. Indus. Engineer. Chem. 22: 908–1010. *Fig. 1–5.*

STEWART, G. F., A. R. GANS AND P. F. SHARP. 1932. The relation of yolk index to interior quality by candling and from the opened egg. The U. S. Egg and Poultry Magazine: 35–39. *Fig. 1–9.* (November).

BIOLOGICAL STUDIES ON THE CUCURBIT-LEAF BEETLE, CERATIA SIMILIS (OLIVIER) (CHRYSOMELIDAE, COLEOPTERA), WITH SPECIAL REFERENCE TO CONTROL WITH ARSENICAL INSECTICIDES [1]

VICTORIANO J. MADRID

WITH TWO TEXT FIGURES

Ceratia similis (Olivier), which is widely distributed in the Philippines and Indo-Malayan countries, is a serious pest of cucurbitaceous plants, such as squash (*Cucurbita maxima* Duchesne), upo (*Lagenaria vulgaris* Ser.), melon (*Cucumis melo* Linn.), cucumber (*Cucumis sativus* Linn.), and others, including wild cucurbits.

Both the larvæ, or grubs, and the adults are destructive. The grub bores into roots or any portion of the plant close to the ground and feeds on the tissues within. The adult feeds on the flower and leaves, leaving only the skeletal portion of the latter. Young plants when attacked by either grubs or adults are often killed or badly stunted. To prevent vacant hills, the common practice is to plant extra seeds in each hill. Then, if infestation occurs, some of the seedlings may escape injury. This method means extravagance in seeds, and if there is no infestation, overcrowding of hills. The adults of the insect, besides feeding on cucurbits, occasionally feed on pollen grains of rice, sugar cane, corn, *Dianthus*, and other plants.

REVIEW OF LITERATURE

Tuason (1917) in his study on the cucurbitaceous vegetables in the Philippines states that squash beetles attack the plants in all their stages of growth. He suggested as remedies ashes or Paris green to be applied as soon as the new leaves were formed.

Garcia (1925) states that lead arsenate was effective in the control of squash beetle.

Howard and Graham (1918) claim that calcium arsenate costs less than lead arsenate and may be substituted for it or Paris green.

---

[1] Thesis presented for graduation, 1933, with the degree of Bachelor of Agriculture from the College of Agriculture, No. 387; Experiment Station contribution, No. 965. Prepared in the Department of Entomology under the direction of Dr. Leopoldo B. Uichanco.

Mumford (1915) in his experiments on control measures against insect pests of melon and related crops found that the striped cucumber beetle (*Diabrotica vittata* Fabr.) can be successfully controlled by dust and spray.

Petch (1919) states that dusting proved almost doubly as expensive as the use of liquids, but by both methods perfect fruit and foliage were produced.

Chittenden (1919) found that lead arsenate spray was superior to Paris green in control of striped cucumber beetle in that it contains a smaller amount of soluble arsenic, thus rendering it less harmful to the plants.

Huckett (1929) in his study on the control of cucumber beetle, *Diabrotica duodecimpunctata* Olivier, found that certain spray mixtures had a far more beneficial effect on plant growth than dust mixtures. He further stated that on a commercial scale, spray was more desirable than dust.

Gibson (1917) reported a satisfactory control of garden pests with the use of Paris green and lead arsenate dust and spray.

According to Cleveland (1926) a satisfactory degree of control of the squash vine borer may be secured by spraying or dusting with certain stomach poisons.

OBJECTS OF THE PRESENT STUDY

The objects were: (*a*) to study the life history, habits, and other biological peculiarities of *Ceratia similis* with the end in view of gaining a clue as to suitable methods of control; (*b*) to ascertain if application of arsenicals would effect satisfactory control of this pest in cucurbits; (*c*) to determine which of the arsenical insecticides ordinarily used is suitable for this purpose; and (*d*) to find out the most suitable form, proportion of ingredients, and manner of use of arsenical insecticides in connection with this work.

TIME AND PLACE OF THE STUDY

The present work was conducted in the Department of Entomology, College of Agriculture, Los Baños. The experimental part was conducted from August, 1930, to September, 1932, covering a period of about two years. Experiments under laboratory conditions were conducted in the Hawaiian Sugar Planters' Insectary which is near the department building. Field experiments were carried on the Los Baños Limnological Station grounds and on a piece of land along the western slope of Faculty Hill. The former field is sandy and is inundated every year by the Laguna de Bay. The latter field

is hilly and slopes toward the north. It was an abandoned caiñgin and was covered with cogon prior to the planting.

It might be mentioned in this connection that the progress of the work was much delayed owing to the inability of the writer to secure, when needed, a site for planting.

MATERIALS AND METHODS

Materials

The three commonly used arsenicals, lead arsenate, Paris green, and calcium arsenate, were tried. These arsenicals had been in storage for a long time in the Department of Entomology. The lead arsenate was manufactured by the California Spray Chemical Company, Watsonville, California, U. S. A. It was guaranteed as follows: active ingredient lead arsenate not less than 96 per cent. Inert ingredients not more than 4 per cent. Total arsenic oxide 30 per cent. Not more than 3/4 of 1 per cent water-soluble compounds of lead arsenate expressed as arsenic oxide. Total amount of arsenic, expressed as per centum of metallic arsenic, not less than 19.5 per cent. The notations on the labels of the other arsenicals were too faded by age to be satisfactorily deciphered.

Watermelon and squash plants at different ages were tested.

For life-history work, adult beetles were collected from the field and confined in battery jars. From the mass cultures, pairs were isolated in separate cages. No soil was put in the bottom of the cage, so that the beetles were forced to deposit their eggs on the surfaces or petiole of the leaf that was supplied as feed.

Methods

Preparation of different combinations of arsenicals. Dust and spray materials were prepared according to the methods discussed by Uichanco (1930).

The efficacy or strength of the various formulae was first given a preliminary test in the insectary and in the field. From the results thus obtained, varying concentrations were developed, as follows:

SPRAYS

Calcium arsenate

Formula 1.	Calcium arsenate	150 grams [2]
	Quicklime	250 "
	Water	100 liters

[2] Original formulae as given by Uichanco (1930); used as basic formulae in the present work.

Formula 2.	Calcium arsenate	160 grams
	Quicklime	250 "
	Water	100 liters
Formula 3.	Calcium arsenate	170 grams
	Quicklime	250 "
	Water	100 liters

Lead arsenate

Formula 4.	Lead arsenate	300 grams[2]
	Quicklime	100 "
	Water	100 liters
Formula 5.	Lead arsenate	340 grams
	Quicklime	100 "
	Water	100 liters
Formula 6.	Lead arsenate	400 grams
	Quicklime	100 "
	Water	100 liters

Paris green

Formula 7.	Paris green	50 grams[2]
	Quicklime	300 "
	Water	100 liters

DUSTS

Calcium arsenate

Formula 8.	Calcium arsenate	1 part by weight
	Air-slaked lime	12 parts by weight
Formula 9.	Calcium arsenate	1 part by weight[2]
	Air-slaked lime	10 parts by weight
Formula 10.	Calcium arsenate	1 part by weight
	Air-slaked lime	8 parts by weight

Lead arsenate

Formula 11.	Lead arsenate	2 parts by weight[2]
	Air-slaked lime	10 parts by weight
Formula 12.	Lead arsenate	2 parts by weight
	Air-slaked lime	5 parts by weight
Formula 13.	Lead arsenate	1 part by weight
	Air-slaked lime	1 part by weight

Paris green

Formula 14.	Paris green	1 part by weight[2]
	Air-slaked lime	40 parts by weight

Methods of application. In the laboratory, the potted plants were arranged in series of replications. In field tests, the field was first divided into lots, in series of replications, with number corresponding to that of the formula. In both the laboratory and the field tests, a bucket force pump fitted with "Giant Simplex" nozzle was

used in applying the sprays. To determine the amount consumed, the volume of the solution was taken before and after spraying.

At the beginning of the experiment, a cheese cloth bag tied on the end of a stick was used in applying the dust. Subsequently, the duster described by Uichanco (1931) was used. To determine the amount of arsenical consumed, the material was weighed before and after each operation.

To ascertain the time for the next spraying, observations were made every other day between eight and ten o'clock in the morning or four and six o'clock in the afternoon. At each visit to the plants, the total number of leaves, the number of leaves attacked and extent of attack, the number of leaves scorched and the extent of damage to the plant were noted. The abundance of the insects was also observed.

Life history. Each batch of eggs obtained from each pair of adults confined was transferred to a pair of Petri dishes and then covered with a thin layer of moist soil. The brim of the dish was lined with absorbent cotton and covered with another dish, to keep the larvae from escaping.

This method was also used in studying the incubation of the eggs. As soon as the eggs hatched and the young larvæ, or grubs, came out of the soil in search of food, each larva was put in a numbered vial. The vials were filled about three-fourths full with fine moist soil. Soft squash stems and, in most cases, petioles were used as feed. These were cut to convenient lengths and covered with soil. The vials were plugged with cotton. The exact time of molting was determined by examining the cultures daily. The soil was poured into a Petri dish and the stem wherein the grub was feeding opened. The feed was changed when necessary.

The exact dates for pupation and emergence were ascertained by making a small slit on one side of the cocoon after it was completed. The cocoon was then replaced in the vial, with the slit toward the bottom, through which subsequent changes in the occupant could be observed without the necessity of disturbing the contents.

The length of time from emergence to first copulation, the length of time from first copulation to first oviposition, the period of fecundity, the number of eggs laid by a female at each laying and the total number of eggs laid by a female were determined by confining pairs of newly emerged males and females in a battery jar (one pair to a jar) covered over the top with cheese cloth. No soil was added at the bottom so that oviposition was made outside and all eggs laid were accounted for. At night, when no observation was made, the

male was separated from the female. The males were restored to their corresponding females at six o'clock in the morning. This was done until first copulation was observed.

DISCUSSION OF RESULTS

Biology of the squash beetle

Habits of the adults. Under ordinary conditions, beetles were found to deposit their eggs in the soil a few millimeters deep near the base of the young plant or near any portion of the plant in contact with the soil. It was observed that in oviposition, the female stretched her ovipositor and inserted it into the ground to a certain depth. Oviposition was aided by pushing each egg with the posterior pair of legs as it came out of the vaginal slit. Under insectary conditions, when soil was withheld from the cages, they had to oviposit on the petiole and surface of the leaf that was supplied as feed.

In the field, oviposition was observed to take place in the early part of the morning and late in the afternoon. The writer believes that on cool days oviposition may take place any time. Most of the eggs, however, were laid at night. It was noted, oftentimes, that while there were no batches of eggs when the cultures were left at from six to six-thirty o'clock in the evening, eggs were found at six o'clock the next morning. The eggs were laid either singly or in masses of two to five around the petiole or on the surface of the leaf that was supplied as feed.

The egg. The egg is subspherical, with the surface rough and marked with irregularly hexagonal reticulations. When freshly laid, it is bright yellow, later turning to dull yellow, when about to hatch. In the 115 sets studied each containing from 17 to 62 eggs, it was found that the minimum incubation period was 8 days; the maximum was 15 days, and the average was 12.10 ± 0.04 days. Upon hatching, the young grubs stayed for some time in the soil and then came out in search of food.

The grub. Under insectary conditions, the grub bored into the host tissues and stayed there until it was about to pupate. There were three instars. The third molting was followed by pupation in the soil. Prior to pupation, as discussed later, the grub spun a cocoon, which was reënforced with fine soil particles.

First instar. The newly hatched larva had a pale yellow body and a light brown head. The first stadium ranged from 4 to 9 days, with an average of 5.58 ± 0.07 days.

Second instar. The freshly molted grub was generally pale, with a comparatively large head. At the end of 24 hours, the body turned

to pale yellow, and the head yellowish-brown and shiny. After 48 hours, the body became orange yellow and the head light brown, without the original luster.

The second stadium ranged from 4 to 10 days, with an average of 6.63 $\pm$ 0.11. It was observed that the grubs began fasting from 1 to 3 days prior to ecdysis and did not resume feeding until one day after molting.

Third instar. The third instar exhibited the same characteristic appearance and behavior as the second instar. Preparatory to the third molt, or pupation, the grub dropped off from the host tissues to the soil and began to construct its cocoon. The cell varied in shape from suboval to subspherical.

The construction of cell was begun from 3 to 12 days from the second molt, with an average of 6.65 $\pm$ 0.13 days. The time from the construction of cell to pupation varied from 3 to 11 days, with an average of 6.15 $\pm$ 0.05 days. The third stadium varied from 6 to 18 days, with an average of 12.97 $\pm$ 0.10 days.

Larval stage. The grubs were very voracious in all stages of growth, except for some time before and after each ecdysis. The duration of larval stage varied from 18 to 35 days, with an average of 25.05 $\pm$ 0.21 days.

Pupal stage. The pupa was elongate, subovoid, similar to adult in general conformation and size of body, pale yellow, and covered by a thin semitransparent membrane. The pupal stage ranged from 4 to 14 days, with an average of 9.33 $\pm$ 0.07 days.

After emergence, the adult stayed for from one to three days inside the cell. It came to the surface of the soil by breaking the cell and working up through the soil particles with its head.

Emergence of adult to first copulation. The adult began to feed as soon as it got to the surface of the soil. The time from emergence to first copulation ranged from 16 to 68 days, with an average of 41.12 $\pm$ 1.37 days. It was observed that as soon as the male and the female were confined together, copulation readily took place. The pair faced each other with the distal ends of their antennae touching each other. After a short while the male turned towards the posterior end of the female, and copulation began. If the female was not responsive, she either moved away from the male or stayed but pushed off the male with her posterior pair of legs as the male crawled on to the posterior end of the female.

On sunny days, copulation took place between seven and ten o'clock in the morning and from four o'clock in the afternoon. However, more copulations were observed in the morning. During

cloudy or cool weather, copulation was observed at any time of the day. Actual copulation lasted for from 1 to 3 hours. During copulation, the pair stopped feeding. The insect did not feed for some time prior to and during copulation, presumably because they had had their fill before seven o'clock. After copulation, if the day was hot, they sought shelter in the shade under the leaves.

First copulation to first oviposition. It was noted that the time from the first copulation to the first oviposition varied from 1 to 46 days, with an average of 19.36 ± 1.53. The number of days from the emergence of female to the first oviposition was found to vary from 37 to 83 days, giving an average of 60.46 ± 0.94 days. The period of fecundity varied from 51 to 137 days, with an average of 87.35 ± 4.65 days. During the period of fecundity, it was found that the number of eggs laid by a female at each laying varied from 17 to 62, the average being 40.27 ± 0.40. The total number of eggs laid by a female during her lifetime was found to vary from 86 to 1,359 eggs, with an average of 517.50 ± 50.33 (table 2).

Longevity of adult. Longevity was determined from 48 pairs of males and females. The result of the observations showed that the adult males lived for from 103 to 238 days, with an average of 174.85 ± 2.91 (table 2); the adult female, from 115 to 225 days, with an average of 167.04 ± 2.36. Hence, there was no significant difference. Likewise, the life expectancy of an adult male is subject to practically the same fluctuation as that of the female, as shown by their coefficients of variation: females, 14.35 ± 0.98 per cent; males, 14.73 ± 0.98 per cent.

Life cycle. The summary of the complete life cycle (from egg to egg) of the squash beetles is shown in table 1. It may be seen from this table that it ranged from 86 to 131 days, with an average of 12.46 ± 0.79.

It may be seen also in table 1 that the most variable part in the different phases of the life history of the beetles is the time from first copulation to first oviposition, with a coefficient of variation of 55.27 ± 3.73 per cent, and the incubation period the least, with a coefficient of variation of 5.17 ± 0.23 per cent. In the entire life cycle, indeed, the highest fluctuation in lengths of time occurred in the events between emergence of adult and first oviposition. The duration of the pupal stage exhibited more than twice as much uniformity as of the larval stage. This condition is to be expected in view of the fact that the pupal, like the egg, stage, represents a period in the life of the insect when it is freed from the necessity of adaptive responses to direct effect of environmental factors.

Duration of the effectiveness of the insecticides

Three principal criteria were used in determining the duration and effectiveness of the insecticides. These were: (*a*) proportion of attacked to sound leaves; (*b*) extent of attack; (*c*) abundance of insects on the leaves. In order to eliminate possible sources of error from moving of insects from the treated to the untreated plants, the various arsenicals in each series were applied in as nearly the same time as practicable. A numerical record of leaves attacked is sometimes misleading for the reason that at times the attack was distributed among different plants, injuring only a small portion of the leaves here and there, while at other times the attack was concentrated on leaves of single plants.

In general, it was found that the insects tried to attack the plant even if it had just been sprayed or dusted. The resulting damage, however, consisted of only a hole or two. No extensive attack was apparent among the treated plants until after a lapse of from 5 to 7 days after insecticidal application, the shorter interval occurring during the early life of the plants. When an insect began to attack, it continued eating until satisfied and often was joined by other individuals. If the treatment was not repeated, the damage was continuous on the unprotected leaves.

It was found that watermelons, melons and squash were very susceptible to injury by *Ceratia similis* during the first three weeks of growth; as a consequence, all but the very vigorous vines frequently succumb. These plants, indeed, especially the watermelons, were found to be attacked by the beetles in all their stages of growth. In all cases, however, the first three weeks of the plant appear to represent the critical period in their career, after which, growth is so well established that subsequent feeding by the beetle seems to occasion no telling injury. Hence, protection with insecticides is important only during the first three weeks after germination, although, in the present work, it was considered safer to prolong the treatment with two additional applications.

Comparative tests on arsenical insecticides

Preliminary tests in cages. The results of the preliminary tests are shown in tables 3, 4, 5, 14, and 16.

Table 3, in which controlled experiments on known initial numbers of beetles were conducted in cages, shows that in general (1) the three arsenicals were more efficacious when applied as dusts than as sprays in the formulae used, and (2) calcium arsenate is more potent in killing the beetles than either lead arsenate or Paris green.

Although Paris green contained a much larger percentage of arsenic than the other two arsenicals, it could not be used in adequately high concentration without danger of scorching the foliage; hence, in the present work it gave the poorest results in the percentage of beetles killed.

Preliminary field tests. Tables 4 and 5 give the results of an attempt to follow up in the field the findings from cage experiments in table 3.

The work was conducted in February, 1931, with squash plants as material on the grounds of the Limnological Station at Mayondon. It may be seen from these tables that (1) plants treated with any of the three arsenicals consistently showed much lower percentages of beetle attack than the untreated; (2) calcium arsenate effected the best control, although the difference with the other arsenicals was not quite as conspicuously marked as in results given in table 3; and (3) the difference between dusting and spraying is very slight, and apparently not significant. Moreover, it will be seen in table 16, that lead arsenate, especially as dust, is the safest to use because it produced but little or no scorching. Calcium arsenate in either form showed a slightly greater tendency to scorch the leaves, more so when used as spray. Paris green, even in the concentration used, which was so low that it could not attain the effectiveness of either lead arsenate or calcium arsenate, resulted in severe scorching. Greater harm was done with the use of Paris green dust than spray. On account of this undesirable quality of that arsenical, it was eliminated in later tests.

Insecticidal effects of various arsenical combinations in the main field experiments. With the basic formulae for dust and spray used in tables 4 and 5 as a starting point, further experiments were conducted in order to determine whether or not better results might be obtained through a modification in the proportion of the active ingredients. The results are given in tables 6 to 14.

It was found that in the control of *Ceratia similis* on watermelon (tables 10, 11, 12, and 13), calcium arsenate, used as spray, gave the most effective control. The spray (formula 3), however, contained more calcium arsenate than the basic formula (No. 1), with greater tendency toward scorching the leaves and is for this reason, undesirable. Calcium arsenate dust, basic formula (No. 9) was only slightly less in effectiveness, with the advantage that it is far safer on the foliage. Apparently, no advantage was gained in increasing the concentration of calcium arsenate to that of formula 10 (table 12).

Lead arsenate spray, basic formula 4, was a very close match to calcium arsenate dust, and in some respects is more desirable because of its uniform harmlessness to the plants. No apparent increase in insecticidal value was gained by using a larger dose of the lead arsenate, as in formula 5 (table 11).

When used as dust, such high concentration of lead arsenate is needed (formulae 12 and 13, table 13) that it would be too expensive. Moreover, the results are inferior to those of lead arsenate spray.

The plants used in the experiments on the control of *Ceratia similis* on squash were too few to warrant the drawing of definite conclusions (tables 6 to 9). However, even on this limited scale, the protection given by arsenicals on the leaves is readily evident when it is considered that nearly one-half the number of leaves of the untreated plants were attacked and only 11.43 to 20.69 per cent of the treated. Lead arsenate dust (formula 13), where a 1:1 mixture was used, gave the best results, but, as pointed out above, the insecticide when used in such a high concentration is expensive. Calcium arsenate spray (formula 3) gave the second best result, but, as has been pointed out, the increased dosage of calcium arsenate over the basic formula 1 results in a severe scorching of the leaves. Lead arsenate spray (formula 6) ranked third, but this mixture contained one-third more arsenical than the basic formula 4. Although there was no scorching of the squash leaves, the added cost in insecticide is an objection. Formula 4, however, gave only a slightly inferior result, and would be preferable to use. Calcium arsenate dust, basic formula 9, was only a little less efficient than the lead arsenate sprays, and perhaps, under farm conditions, the small difference would be negligible. As in the case of watermelons, no apparent advantage was gained in increasing the concentration of calcium arsenate in the dust (formula No. 10).

In tables 6 to 13, another guide that may be used in judging degree of effectiveness of insecticidal treatment is the coefficient of variation. It is invariably very much smaller in the control, indicating that the extent of damage on the leaves is much more uniform than in the treated lots. The coefficients of variation for the lots in which insecticides were used was higher, as a rule, as the arsenical mixture in the formulae used provided more adequate protection.

In the computation of the attacked leaves given in the foregoing tables, one important consideration had to be neglected, and that was the extent of damage on the leaves. The unprotected leaves were

almost invariably wholly skeletonized while those treated with arsenicals were eaten only in parts along the edges or on one or two small parts of the leaf lamina.

Likewise, the rate of mortality of plants was very much greater in the control than in the treated. Table 14 shows the percentage of mortality in the treated and untreated lots due to the attack of

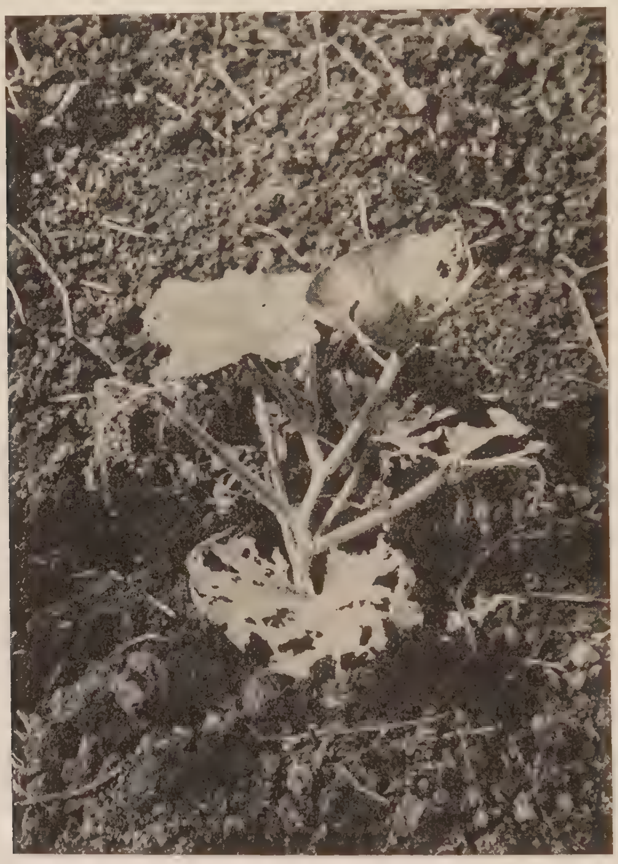


Fig. 1.—A squash plant five weeks old which received no insecticide treatment.

the adult beetles. In the case of watermelon, the dead plants in the treated lots ranged from 0 to 6.12 per cent, while in the control they were 24.5 per cent. The squash planted at Mayondon, January, 1931, showed a mortality of 45.83 per cent in the control, while in the treated it ranged from only 8 to 16.17 per cent. The upper range in the latter, however, seems to be very exceptional, because it occurred in only one of the seven plots treated; the majority showed only 8.33

per cent. Most of the plants that died in the treated lots were attacked at the base of the epicotyl, while in the control most of those that died were seriously mutilated all over.

A comparative stand of treated and untreated plants is illustrated in figures 1 and 2. Figure 1 shows the stand of an untreated

Fig. 2.—A squash plant five weeks old which received insecticidal treatment.

plant and figure 2 of a treated plant of the same age. It should be pointed out in this connection that compared with the undamaged, severely attacked plants, although they survived, were very much delayed in flowering.

Tolerance of cucurbit leaves to the various insecticides tested

Table 16 shows the scorching effect on squash leaves of the different insecticides tested. Of them all, Paris green proved to

be most dangerous even if applied in the least amount possible. It will be seen that Paris green scorched about 15.29 and 7.59 per cent in the dusted and sprayed lots, respectively. Two days after application, water-soaked patches began to appear on the surface of the leaves that had been dusted and along the border in case of the sprayed leaves. Later on these areas grew larger and then died off. In severe cases, the leaves were rolled inward as if they had been heated over fire. Paris green scorched both the old and the young leaves, but more of the old ones.

Calcium arsenate was found to scorch leaves much less than Paris green but a little more than lead arsenate. It may be seen in table 16 that calcium arsenate dust produced 0.46 per cent scorched leaves; the spray, 0.90 per cent.

Lead arsenate was the safest. Scorched leaves rarely appeared even if the arsenate was applied quite liberally, and then only after several applications, owing, perhaps, to a cumulative effect of the arsenical.

Cost of application

Using the best formulae found in this work, it may be seen (table 15) that there was not much difference in the cost of operation between dusting and spraying. It was found, however, that with the equipments and methods used, it took a longer time to dust than to spray an equal area. The reason for this is that in dusting the area that could be reached from one station was much smaller than in spraying.

In the present work it was found that it cost from ₱0.33 to ₱0.35 to spray 100 watermelon plants; ₱0.37 to dust the same number. It cost ₱0.34 to spray 100 squash plants; ₱0.39 to dust the same number.

Time of insecticide application

It was found in the present work that adults feed voraciously from six to ten o'clock in the morning and from four o'clock in the afternoon. Hence, the proper time to apply the insecticide was before six o'clock in the morning and about three-thirty in the afternoon.

Spraying applied in the afternoon was found to be best. When spray was applied in the morning it was found to scorch the leaves more readily. The leaves being wet with dew, droplets of water were readily formed even if only a small amount of the spray came in contact with the surface. These droplets either stayed on the middle or flowed to the edges, depositing there a high concentration of arsenicals and causing burning. When applied in the afternoon,

the wetting of the leaves was easily regulated. Dusting was done best early in the morning while the leaves were still wet with dew and the air was calm. Even a moderate breeze carried away the dust. Trials on application of dust on windy days resulted in too much waste of material. Dust when applied in the afternoon did not stick firmly on the leaves.

Another limiting factor in the application of insecticide was the frequent rainfall in the vicinity of Los Baños.

When and how to apply insecticides

Squash and watermelon were found to be very susceptible to squash-beetle attack in the early stages of their growth. The same is probably true with all cucurbits. The beetle began to attack the plants as soon as they came out of the ground, more vigorously when the first true leaves are being formed. Hence, it is necessary to visit the plantation frequently when the plants are beginning to sprout so that control measures may be applied promptly.

Lead arsenate spray (formula 4), calcium arsenate dust (formula 9), and calcium arsenate spray (formula 1) were found effective in controlling the beetle. The last one, however, should be used with caution, on account of its tendency to scorch leaves. Frequency of treatment may be determined by the abundance of insect and the weather conditions. It was, however, found in the present work that five applications at intervals of from 5 to 9 days, the shorter intervals during the early life of the plants, gave sufficient protection from beetle attack.

SUMMARY AND CONCLUSIONS

1. The squash beetle, *Ceratia similis* (Olivier), is a serious, and apparently the worst, pest of squash, watermelon, upo, cucumber, and other cucurbitaceous plants in the Philippines.

2. In addition to cucurbitaceous plants, the adults occasionally feed on the pollen grains of rice, corn, sugar cane, *Dianthus* (also on petals of this plant) and other plants.

3. The beetles feed actively from six to ten o'clock in the morning and from four o'clock in the afternoon.

4. During cool weather, the female was found to oviposit at any time of the day. However, most of the eggs were laid either late in the afternoon or in the evening.

5. In the open, the eggs were laid near the stem of the host plant below the surface of the soil. Under laboratory conditions when the soil was withheld, the eggs were deposited either singly

or in masses of 2 to 5 on the surface or petiole of the leaf that was supplied as feed.

6. The incubation period of the eggs varied from 8 to 15 days, with an average of 12.10 ± 0.04 days.

7. Under laboratory conditions, the larva bored into the stem that was supplied as feed, coming out only when the feed decayed.

8. The larvae were very voracious in all stages of growth, except for some time before and after each ecdysis.

9. There were three larval instars. The third molt marked the transition to the pupal stage.

10. The first stadium varied from 4 to 9 days, with an average of 5.58 ± 0.07.

11. The second stadium varied from 4 to 10 days, with an average of 6.63 ± 0.11 days.

12. Three to twelve days, or an average of 6.65 ± 0.13, from the second molt, the larvae dropped off from the host tissues to the soil to spin their cocoon. The lapse of time from spinning cocoon to pupation varied from 3 to 11 days, with an average of 6.15 ± 0.05 days.

13. The third stadium varied from 6 to 18 days, with an average of 12.97 ± 0.10 days.

14. The duration of the larval stage varied from 18 to 35 days, with an average of 25.05 ± 0.21 days.

15. The duration of pupal stage ranged from 4 to 14 days, with an average of 9.33 ± 0.07 days.

16. The lapse of time from emergence of adult to first copulation varied from 16 to 68 days, with an average of 41.12 ± 1.37 days. From the first copulation to the first oviposition, the time varied from 1 to 46 days, with an average of 19.36 ± 1.53 days. Hence, the total length of time from emergence of adult to first oviposition varied from 37 to 83 days, with an average of 60.46 ± 0.94 days.

17. The period of fecundity ranged from 51 to 137 days, with an average of 87.35 ± 4.66. A female laid at each oviposition from 17 to 62 eggs, with an average of 40.27 ± 0.40. The total number of eggs produced by a female during her life time varied from 86 to 1,359, with an average of 517.50 ± 50.33.

18. The adult female lived for from 115 to 225 days, with an average of 167.04 ± 2.36. The adult male lived for from 103 to 238 days, with an average of 174.85 ± 2.91, so that there was no significant difference between the male and the female on this point.

19. The complete life cycle (from egg to egg) ranged from 86 to 131 days, with an average of 104.84 ± 11.75 days.

20. Squash and watermelon, especially the latter, were found to be attacked by beetles in all stages of growth.

21. The first three to four weeks of growth of the plants are the most critical period with respect to the attack of the beetles.

22. Plants that were severely damaged were often killed or stunted in growth. In the present work the rate of mortality in the untreated plants ranged from 38 to 46 per cent; in the treated, from 0 to 14 per cent.

23. Plants severely attacked in their early stage, even if they survived, were often delayed in flowering.

24. Lead arsenate spray (formula 4) and calcium arsenate either in the form of dust (formula 9) or spray (formula 1) were found effective in controlling the attack of the beetles. Calcium arsenate spray, however, has the tendency to burn the leaves. Paris green is absolutely dangerous and is not recommended for use, owing to its severe scorching effect on the foliage. Moreover, the price of Paris green is double that of either lead arsenate or calcium arsenate.

25. In the present work three applications at intervals of from 5 to 7 days, the first when the seedlings have the leaves completely forming, were sufficient to protect the plants from infestation during this critical period in their growth. Two extra applications further insured the plants from severe injury.

26. The total cost of application for dust and spray was approximately the same, and the resulting protection about equal. In cases where the cultivation of cucurbits is only a side line, dust is preferable because, once prepared, it can be kept indefinitely and is ready for use in the improvised hand duster. When growing the cucurbit on a commercial scale, however, spraying would probably be more economical than dusting.

LITERATURE CITED

CHITTENDEN, F. H. 1919. The striped cucumber beetle and its control. U. S. Dept. Agric. Farmers' Bull. 1038: 1–11. *Fig. 1–15.*

CLEVELAND, C. R. 1926. Stomach poison for control of the squash vine borer (*Milittia styriniformis* Hbn.) Jour. Econ. Entomol. 20: 135–143.

GARCIA, C. E. The squash beetle, *Orthaulaca similis* Olivier. (Thesis presented for graduation with the degree of Bachelor of Agriculture from the College of Agriculture. Unpublished. 1925.)

GIBSON, A. 1917. Common garden insects and their control. Jour. Econ. Entomol. 6: 337.

GRAHAM, S. A. 1918. Potato spraying. 17th Report Minnesota State Entomologist, Agric. Expt. Sta., Univ. Farm, St. Paul. December, 1918, pp. 21–31. *1 fig.* *Cited in* Rev. Appl. Entomol. **7**: 325.

HOWARD, L. O. 1918. Report of the Entomologist. U. S. Dept. Agric. Bur. Entomology, Washington, D. C., September, 1918. *Cited in* Rev. Appl. Entomol. **7**: 101.

HOWARD, L. O. 1919. Report of the Entomologist. U. S. Dept Agric. Bur. Entomology, Washington, D. C., August, 1919. *Cited in* Rev. Appl. Entomol. **8**: 92.

MUMFORD, F. B. 1915. How the station works. *Cited in* Rev. Appl. Entomol. **5**: 127.

PETCH, C. E. 1919. Dusting and spraying suggestions for Quebec. 11th Annual Report Quebec Society of Protecting Plants from Insects and Fungous Diseases, 1918–1919; Quebec 1919, pp. 27–28. *Cited in* Rev. Appl. Entomol. **7**: 525.

TUASON, D. S. 1917. A study of cucurbitaceous vegetables in the Philippines. The Philippine Agriculturist and Forester **5**: 315–342. *Pl. 1–6.*

UICHANCO, L. B. 1930. Laboratory exercises in entomology 1. 4th ed., 1–98. Los Baños: College of Agriculture (Mimeographed copy).

UICHANCO, L. B. 1931. A handy duster for the small garden. The Philippine Agriculturist **20**: 647–649. *Fig. 1.*

TABLE 1

Summary of the life history of Ceratia similis (August 24, 1930-June 26, 1931)

STADIA	DURATION	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	days	*days*	*per cent*
Incubation period of eggs (115 cultures)			
Maximum	15		
Minimum	8		
Average	12.10 ± 0.04	0.63 ± 0.03	5.17 ± 0.23
First stadium (164 cultures)			
Maximum	9		
Minimum	4		
Average	5.58 ± 0.07	1.32 ± 0.04	23.58 ± 0.88
Second stadium (164 cultures)			
Maximum	10		
Minimum	4		
Average	6.63 ± 0.11	1.46 ± 0.05	22.05 ± 0.82
From second molt to spinning of cocoon (164 cultures)			
Maximum	12		
Minimum	3		
Average	6.65 ± 0.13	1.67 ± 0.06	25.10 ± 0.93
Spinning of cocoon to pupation (164 cultures)			
Maximum	11		
Minimum	3		
Average	6.15 ± 0.05	1.32 ± 0.05	21.40 ± 0.80
Third stadium (164 cultures)			
Maximum	18		
Minimum	6		
Average	12.97 ± 0.10	1.90 ± 0.07	14.64 ± 0.54
Larval stage (164 cultures)			
Maximum	35		
Minimum	18		
Average	25.05 ± 0.21	2.71 ± 0.01	29.36 ± 1.09
Pupal stage (164 cultures)			
Maximum	14		
Minimum	4		
Average	9.33 ± 0.07	1.38 ± 0.05	14.78 ± 0.55
Emergence of adult to first copulation (50 pairs)			
Maximum	68		
Minimum	16		
Average	41.12 ± 1.37	14.83 ± 1.00	36.08 ± 2.43
First copulation to first oviposition (50 pairs)			
Maximum	46		
Minimum	1		
Average	19.36 ± 1.53	10.70 ± 0.72	55.27 ± 3.73
Emergence of adult to first oviposition (50 pairs)			
Maximum	83		
Minimum	37		
Average	60.46 ± 0.94	9.79 ± 0.66	16.19 ± 1.09
Life cycle—egg to egg (164 cultures)			
Maximum	131		
Minimum	86		
Average	104.84 ± 11.75	13.06 ± 0.83	12.46 ± 0.79

TABLE 2

Summary of reproduction of Ceratia similis (August 23, 1931 to April 4, 1932)

	DURATION	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	days	*days*	*per cent*
Period of fecundity (20 pairs)			
Maximum	137		
Minimum	51		
Average	87.35± 4.66	20.30± 2.16	23.23±2.48
Longevity of adult female (48 individuals)			
Maximum	225		
Minimum	115		
Average	167.04± 2.36	23.97± 1.63	14.35±0.98
Longevity of adult male (48 individuals)			
Maximum	238		
Minimum	103		
Average	174.85± 2.91	30.22± 2.06	14.73±1.00
Number of eggs laid daily by a female (20 individuals)			
Maximum	62		
Minimum	17		
Average	40.27± 0.40	9.56± 0.28	23.74±0.71
Total number of eggs laid by a female during period of fecundity (20 individuals)			
Maximum	1,359		
Minimum	86		
Average	517.50±50.33	331.72±35.38	64.10±6.84

TABLE 3

Relative efficacy of the basic formulae for arsenical dusts and sprays in the control of Ceratia similis (in cages)

INSECTICIDES USED	INITIAL NUMBER OF BEETLES	INSECTS KILLED						TOTAL MORTALITY FOR 6 DAYS	
		First day	Second day	Third day	Fourth day	Fifth day	Sixth day		
		number	*number*	*number*	*number*	*number*	*number*	*number*	*per cent*
Sprays									
Lead arsenate									
Formula 4	146	6	10	18	21	22	21	99	67.88
Calcium arsenate									
Formula 1	146	7	12	19	23	21	24	106	72.60
Paris green									
Formula 7	146	4	8	19	18	20	20	89	61.64
Control	146	0	0	0	0	0	0	0	0.00
Dusts									
Lead arsenate									
Formula 11	158	7	16	16	24	30	28	121	76.58
Calcium arsenate									
Formula 9	158	8	15	14	29	30	37	133	84.17
Paris green									
Formula 14	158	5	19	19	24	14	29	112	70.82
Control	158	0	0	0	0	0	0	0	0.00

TABLE 4

Summary of the effect of arsenical dusts in the control of Ceratia similis on squash leaves; planted in Mayondon Limnological Station grounds in January, 1931

TREATMENT	PLANTS EXAMINED	LEAVES ATTACKED [a]	STANDARD DEVIATION	COEFFICIENT OF VARIATION	DIFFERENCE OF TWO MEANS (CONTROL MINUS TREATED)
	number	*per cent*	*per cent*	*per cent*	*per cent*
Lead arsenate [b]					
Formula 11	12	22.89 ± 4.02	16.84 ± 2.62	73.57 ± 11.69	37.16 ± 6.65
Calcium arsenate					
Formula 9	12	19.20 ± 3.03	12.73 ± 2.02	66.29 ± 10.44	40.85 ± 6.10
Paris green					
Formula 14	12	21.43 ± 3.35	15.19 ± 2.40	76.06 ± 12.09	38.62 ± 6.26
Control	24	60.05 ± 5.29	96.14 ± 11.46	160.10 ± 19.09	—

[a] Based on total number of leaves counted, February 12, 1931.
[b] See text for formulae.

TABLE 5

Summary of the effect of arsenical sprays in the control of Ceratia similis on squash leaves; planted in Mayondon Limnological Station grounds in January, 1931

TREATMENT	PLANTS EXAMINED	LEAVES ATTACKED [a]	STANDARD DEVIATION	COEFFICIENT OF VARIATION	DIFFERENCE OF TWO MEANS (CONTROL MINUS TREATED)
	number	*per cent*	*per cent*	*per cent*	*per cent*
Lead arsenate [b]					
Formula 4	12	23.63 ± 5.53	23.20 ± 3.69	98.19 ± 15.60	36.42 ± 7.66
Calcium arsenate					
Formula 1	12	18.84 ± 3.27	14.57 ± 2.20	77.36 ± 11.67	41.21 ± 6.22
Paris green					
Formula 7	12	20.97 ± 3.54	14.83 ± 2.37	70.73 ± 11.24	39.08 ± 6.37
Control	24	60.05 ± 5.29	96.14 ± 11.46	160.10 ± 19.09	—

[a] Based on total number of leaves counted, February 12, 1931.
[b] See text for formulae.

TABLE 6

Summary of the effect of calcium arsenate sprays of different concentrations in the control of Ceratia similis on squash leaves; planted on Faculty Hill in January, 1932

TREATMENT	PLANTS EXAMINED	LEAVES ATTACKED [a]	STANDARD DEVIATION	COEFFICIENT OF VARIATION	DIFFERENCE OF TWO MEANS (CONTROL MINUS TREATED)
	number	*per cent*	*per cent*	*per cent*	*per cent*
Formula 1 [b]	8	17.78 ± 2.52	9.87 ± 1.66	55.51 ± 9.36	31.63 ± 8.82
Formula 2	9	15.69 ± 2.43	10.19 ± 1.62	64.97 ± 10.33	33.72 ± 8.79
Formula 3	9	13.95 ± 2.70	11.34 ± 1.80	81.27 ± 12.90	35.46 ± 8.87
Control	37	49.41 ± 8.45	14.46 ± 2.82	29.26 ± 5.70	—

[a] Based on the total number of leaves counted, February 16, 1932.
[b] See text for formulae.

TABLE 7

Summary of the effect of lead arsenate sprays of different concentrations in the control of Ceratia similis on squash leaves; planted on Faculty Hill in January, 1932

TREATMENT	PLANTS EXAMINED	LEAVES ATTACKED [a]	STANDARD DEVIATION	COEFFICIENT OF VARIATION	DIFFERENCE OF TWO MEANS (CONTROL MINUS TREATED)
	number	*per cent*	*per cent*	*per cent*	*per cent*
Formula 4 [b]	6	19.05 ± 2.40	8.73 ± 1.86	45.81 ± 9.77	30.36 ± 8.79
Formula 5	7	18.18 ± 3.67	12.17 ± 2.37	66.96 ± 13.04	31.23 ± 8.86
Formula 6	9	16.67 ± 3.82	15.92 ± 2.53	95.47 ± 15.18	32.74 ± 9.27
Control	37	49.41 ± 8.45	14.46 ± 2.82	29.26 ± 5.70	—

[a] Based on the total number of leaves counted, February 16, 1932.
[b] See text for formulae.

TABLE 8

Summary of the effect of calcium arsenate dusts of varying concentrations in the control of Ceratia similis on squash leaves; planted on Faculty Hill in January, 1932

TREATMENT	PLANTS EXAMINED	LEAVES ATTACKED [a]	STANDARD DEVIATION	COEFFICIENT OF VARIATION	DIFFERENCE OF TWO MEANS (CONTROL MINUS TREATED)
	number	*per cent*	*per cent*	*per cent*	*per cent*
Formula 8 [b]	8	21.15 ± 4.38	17.18 ± 2.90	81.21 ± 13.69	28.26 ± 9.52
Formula 9	7	19.35 ± 2.80	6.27 ± 1.34	35.55 ± 6.46	30.06 ± 8.80
Formula 10	7	19.96 ± 6.36	23.24 ± 4.19	116.42 ± 20.99	29.45 ± 10.58
Control	37	49.41 ± 8.45	14.46 ± 2.82	29.26 ± 5.70	—

[a] Based on the total number of leaves counted, February 16, 1932.
[b] See text for formulae.

TABLE 9

Summary of the effect of lead arsenate dusts of varying concentrations in the control of Ceratia similis on squash leaves; planted on Faculty Hill in January, 1932

TREATMENT	PLANTS EXAMINED	LEAVES ATTACKED [a]	STANDARD DEVIATION	COEFFICIENT OF VARIATION	DIFFERENCE OF TWO MEANS (CONTROL MINUS TREATED)
	number	*per cent*	*per cent*	*per cent*	*per cent*
Formula 11 [b]	6	18.42 ± 4.64	15.38 ± 2.99	83.47 ± 16.25	30.99 ± 9.64
Formula 12	7	20.69 ± 5.95	21.60 ± 3.89	104.40 ± 18.82	28.72 ± 10.33
Formula 13	6	11.43 ± 4.98	14.08 ± 3.89	123.14 ± 26.27	37.98 ± 10.35
Control	37	49.41 ± 8.45	14.46 ± 2.82	29.26 ± 5.70	—

[a] Based on the total number of leaves counted, February 16, 1932.
[b] See text for formulae.

TABLE 10

Summary of the effect of calcium arsenate sprays of varying concentrations in the control of Ceratia similis on watermelon leaves; planted in Mayondon in February, 1932

TREATMENT	PLANTS EXAMINED	LEAVES ATTACKED [a]	STANDARD DEVIATION	COEFFICIENT OF VARIATION	DIFFERENCE OF TWO MEANS (CONTROL MINUS TREATED)
	number	*per cent*	*per cent*	*per cent*	*per cent*
Formula 1 [b]	51	11.04 ± 0.10	9.96 ± 0.72	86.95 ± 6.25	24.29 ± 1.87
Formula 2	46	10.27 ± 0.81	7.44 ± 0.57	58.08 ± 4.44	25.06 ± 1.00
Formula 3	48	8.81 ± 1.39	12.45 ± 0.95	115.06 ± 8.79	26.52 ± 1.51
Control	200	37.79 ± 0.58	10.45 ± 0.41	24.16 ± 0.95	—

[a] Based on the total number of leaves counted, March 24, 1932.
[b] See text for formulae.

TABLE 11

Summary of the effect of lead arsenate sprays of varying concentrations in the control of Ceratia similis on watermelon leaves; planted in Mayondon in February, 1932

TREATMENT	PLANTS EXAMINED	LEAVES ATTACKED [a]	STANDARD DEVIATION	COEFFICIENT OF VARIATION	DIFFERENCE OF TWO MEANS (CONTROL MINUS TREATED)
	number	*per cent*	*per cent*	*per cent*	*per cent*
Formula 4 [b]	52	10.19 ± 1.75	17.04 ± 1.23	141.95 ± 10.21	25.14 ± 1.85
Formula 5	49	10.09 ± 1.41	13.57 ± 0.99	114.96 ± 8.36	25.24 ± 1.53
Formula 6	45	13.90 ± 0.94	7.88 ± 0.65	53.34 ± 4.43	21.43 ± 1.11
Control	200	37.79 ± 0.58	10.45 ± 0.41	24.16 ± 0.95	—

[a] Based on the total number of leaves counted, March 24, 1932.
[b] See text for formulae.

TABLE 12

Summary of the effect of calcium arsenate dusts of varying concentrations in the control of Ceratia similis on watermelon leaves; planted in Mayondon in February, 1932

TREATMENT	PLANTS EXAMINED	LEAVES ATTACKED [a]	STANDARD DEVIATION	COEFFICIENT OF VARIATION	DIFFERENCE OF TWO MEANS (CONTROL MINUS TREATED)
	number	*per cent*	*per cent*	*per cent*	*per cent*
Formula 8 [b]	49	11.97 ± 1.10	10.52 ± 0.77	72.18 ± 5.25	23.36 ± 1.15
Formula 9	47	10.84 ± 1.91	17.52 ± 1.34	115.33 ± 8.81	24.49 ± 1.99
Formula 10	47	10.83 ± 1.72	16.60 ± 1.19	105.19 ± 7.56	24.40 ± 1.81
Control	200	37.79 ± 0.58	10.45 ± 0.41	24.16 ± 0.95	—

[a] Based on the total number of leaves counted, March 24, 1932.
[b] See text for formulae.

TABLE 13

Summary of the effect of lead arsenate dusts of varying concentrations in the control of Ceratia similis on watermelon leaves; planted in Mayondon, February, 1932

TREATMENT	PLANTS EXAMINED	LEAVES ATTACKED [a]	STANDARD DEVIATION	COEFFICIENT OF VARIATION	DIFFERENCE OF TWO MEANS (CONTROL MINUS TREATED)
	number	*per cent*	*per cent*	*per cent*	*per cent*
Formula 11 [b]	46	15.11 ± 1.26	11.55 ± 0.88	73.68 ± 5.63	20.22 ± 1.39
Formula 12	49	11.38 ± 1.10	10.57 ± 0.77	70.35 ± 5.12	23.95 ± 1.25
Formula 13	49	11.70 ± 1.21	11.76 ± 0.87	84.82 ± 6.25	23.63 ± 1.35
Control	200	37.79 ± 0.58	10.45 ± 0.41	24.16 ± 0.95	—

[a] Based on the total number of leaves counted, March 24, 1932.
[b] See text for formulae.

TABLE 14

Plants in treated and untreated lots that were attacked by Ceratia similis

TREATMENT	MELON PLANTED IN MAYONDON, FEBRUARY, 1932			SQUASH PLANTED ON FACULTY HILL, JANUARY, 1932			SQUASH PLANTED IN MAYONDON, JANUARY, 1931		
	Plants observed	Plants that died result of attack		Plants observed	Plants that died result of attack		Plants observed	Plants that died result of attack	
	number	*number*	*per cent*	*number*	*number*	*per cent*	*number*	*number*	*per cent*
Sprays									
Lead arsenate									
Formula 4	52	2	3.45	6	0	0	12	1	8.33
" 5	49	1	2.04	7	1	14.29	—	—	—
" 6	45	3	6.67	9	0	0	—	—	—
Calcium arsenate									
Formula 1	51	2	3.92	8	0	0	12	1	8.33
" 2	46	3	6.52	9	0	0	—	—	—
" 3	48	2	4.17	9	0	0	—	—	—
Paris green									
Formula 7	—	—	—	—	—	—	12	1	8.33
Dusts									
Lead arsenate									
Formula 11	46	1	2.17	6	0	0	12	1	8.33
" 12	49	2	4.08	7	0	0	—	—	—
" 13	49	1	2.04	6	0	0	—	—	—
Calcium arsenate									
Formula 8	49	3	6.12	8	0	0	—	—	—
" 9	47	2	4.26	7	1	14.29	12	2	16.17
" 10	47	0	0.00	7	1	14.29	—	—	—
Paris green									
Formula 14	—	—	—	—	—	—	12	1	8.33
Control (No treatment)	200	59	24.50	37	14	37.84	24	11	45.83

TABLE 15

Computed cost of insecticidal treatment for 100 plants, using the best formulae found in the present work

WATERMELON PLANTED IN MAYONDOÑ, FEBRUARY, 1932

ARSENICALS USED	Plants	Frequency of application	Quantity and cost of materials: Arsenical, Quantity	Quantity and cost of materials: Arsenical, Cost [a]	Quantity and cost of materials: Lime, Quantity	Quantity and cost of materials: Lime, Cost	Duration of operation: Time spent	Duration of operation: Cost at ₱0.10 per hour	Total cost
	number	*times*	*grams*	*pesos*	*grams*	*pesos*	*hours*	*pesos*	*pesos*
Sprays									
Calcium arsenate									
Formula 1	100	5	29.95	0.030	49.92	0.050	2.5	0.25	0.330
Lead arsenate									
Formula 4	100	5	51.34	0.077	17.11	0.017	2.6	0.26	0.354
Dusts									
Calcium arsenate									
Formula 9	100	5	6.37	0.006	63.70	0.064	3.0	0.30	0.370

SQUASH PLANTED ON FACULTY HILL, JANUARY, 1932

ARSENICALS USED	Plants	Frequency of application	Quantity and cost of materials: Arsenical, Quantity	Quantity and cost of materials: Arsenical, Cost [a]	Quantity and cost of materials: Lime, Quantity	Quantity and cost of materials: Lime, Cost	Duration of operation: Time spent	Duration of operation: Cost at ₱0.10 per hour	Total cost
	number	*times*	*grams*	*pesos*	*grams*	*pesos*	*hours*	*pesos*	*pesos*
Sprays									
Calcium arsenate									
Formula 1	100	6	38.56	0.039	64.27	0.064	3.4	0.34	0.443
Lead arsenate									
Formula 4	100	6	132.03	0.198	44.01	0.044	3.4	0.34	0.582
Dusts									
Calcium arsenate									
Formula 9	100	6	6.83	0.068	68.25	0.068	3.9	0.39	0.526

[a] Figures based on quotations from Botica Boie, Manila, in letter of September 9, 1933.

TABLE 16

Effect of different arsenicals tested on squash leaves

ARSENICALS	DOSAGE PER PLANT	TOTAL LEAVES EXAMINED	LEAVES SCORCHED		OBSERVATIONS
	grams	*number*	*number*	*per cent*	
Sprays					
Lead arsenate Formula 4	1.140	409	2	0.48	Scorching very negligible, and only on old leaves at last spraying.
Calcium arsenate Formula 1	0.271	435	4	0.90	Slightly scorched, only old leaves scorched, after the third application.
Paris green Formula 7	0.018	303	23	7.59	Scorching even after the first application; both young and old leaves affected; some plants stunted.
Dusts					
Lead arsenate Formula 11	0.299	344	0	0.00	No leaf scorched.
Calcium arsenate Formula 9	0.072	427	2	0.46	Leaves slightly scorched; scorching after several applications.
Paris green Formula 14	0.030	255	39	15.29	Leaves severely scorched, rolled upward as if burned. Old and young leaves affected. Some plants stunted.

A STUDY OF THE IMMEDIATE EFFECTS OF DETASSELING UPON THE YIELD OF CALAUAN YELLOW FLINT CORN PLANTED EAR-TO-THE-ROW, AND BY THE ORDINARY METHOD [1]

FRANCISCO R. ISIDORO

INTRODUCTION

Various methods of improving the yield of our corn have been tried. It seems important that the best of these methods be studied with the idea of finding out if they are applicable to Philippine conditions.

The work of detasseling alternating half-rows, as employed in this study, is involved in inbreeding and crossbreeding practices. In the case of an undetasseled half-row on each side of which are detasseled rows, there is a chance of inbreeding in the plants. In the case of a detasseled half-row, on either side of which is an undetasseled row, crossbreeding will surely take place for there are not pollen grains to fertilize the detasseled plants except those from the plants of the neighboring rows. The aim in removing the tassels is to insure cross-pollination of the detasseled plants, and self-pollination in the case of the tasseled plants. The effect of these two kinds of fertilization on the yield is then determined.

Mendiola (1914) in his work on hybridization of corn determined among other things the effect of detasseling on the parent rows alternating with the first generation hybrids and found that there was a gain of 18 per cent in grain yield in favor of the detasseled rows.

Goco (1921) working on the pedigree selection with Native Yellow Flint corn found that the yield per plant of detasseled rows exceeded by 2.96 grams each plant in the undetasseled rows.

Salva Cruz (1921) in his study on the effect of mass selection upon the yield of corn using the Native Yellow Flint variety noted a decrease in production by 29.5 per cent in the inbred rows.

---

[1] Thesis presented for graduation, 1931, with the degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 388; Experiment Station contribution No. 966. Prepared in the Department of Agronomy under the direction of Mr. Vicente B. Aragon and Dr. Nemesio B. Mendiola.

Nisperos (1929) in inbreeding the Native Yellow Flint corn noted a decrease in yield. This finding was corroborated by Salvado (1930) in a similar study.

As far as the writer knows there has been no specific work done in the past in the Philippines exclusively on determining the effect of detasseling upon the yield of corn. The practice of detasseling, however, has become a feature in the different methods of selection.

The objects of the work reported in this paper were to find the effect of detasseling upon the yield of corn. And, to find which of the two ways of planting corn when accompanied by detasseling; namely, the ear-to-the-row or the ordinary method will yield the better crop.

The experiment was carried out in a portion of the Experiment Station of the College of Agriculture, from June, 1930 to September, 1931.

MATERIALS AND METHODS

Variety used and seed selection

The Calauan Yellow Flint corn which is widely grown in the College and its vicinity was used in this study. It appears to be adapted to climatic and soil conditions existing in the College.

The ears used for seed were selected from a stock previously raised by the Agronomy Department. For the ear-to-the-row test, 101 ears were selected. Each ear was put in a paper bag. The bags were numbered 0, 1, 2, 3, 4 and so on up to 100. Each bag number represented the number of the ear contained in that bag. Ears 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 were designated check ears.

About 150 ears were selected for the ordinary method of planting. The size of the ears, appearance of seeds, arrangement of kernels, and condition of tips and butts were used as the bases for selection. These selected ears were kept in a large tin can until they were shelled. Seed for the ear-to-the-row test in the second planting was obtained from the undetasseled rows of the first planting, and the same planting plan was followed.

Preparation of the seed and field

For the ear-to-the-row test each ear was shelled and the kernels placed in the bag where the ear had been kept, care being taken in shelling that no kernel from around the tip and butt of the ear was put in the bag.

The ears selected for the ordinary method of planting were shelled and the kernels mixed in a container. The seeds were then stored.

The field was prepared by the Agronomy Department. It was divided into two lots. In each lot 101 furrows were made one meter apart and about 80 meters long. One lot was used for the ear-to-the-row test and the other lot for the ordinary method of planting.

Planting and cultivation

In the ear-to-the-row method the seeds from each bag were planted in a row. The ear number corresponded to the row number in the field. Thus seeds from ears 0, 1, 2, 3, etc. were planted in rows numbered 0, 1, 2, 3, etc. Each row was planted with 100 hills with 3 to 5 seeds to a hill. The rows where the seeds from check ears 0, 10, 20, 30 etc. were planted became the check rows for that lot.

In the ordinary method of planting, the mixed kernels from the mass selected ears were planted in a manner similar to that described for the ear-to-the-row lot.

When the plants were about 30 cm. high they were thinned out to two plants in a hill, the idea being to have, so far as possible, a uniform number of plants in the rows, and to provide space for the growth of the plants.

Because of the prevalence of noxious weeds, the field was weeded by hoeing. When the plants were about 45 to 60 cm. in height the spaces between the rows were plowed. The field was weeded by hoeing from time to time.

Tasseling and detasseling

Detasseling was begun as soon as the tassels emerged and before the flowers opened. It was done by removing the tassels from the plants of the alternating half-rows. The tassels were pulled out carefully so as not to pull out the young leaves that will come out with the tassels if these are pulled out quickly with force. All the check rows in both lots were completely detasseled.

Since corn plants do not flower at the same time detasseling was done several times, until all the tassels in the detasseled halves of the rows and in the check rows were removed.

The plan and operation of the experiment are shown in the following diagram:

Row 0	completely detasseled	
" 1	detasseled	undetasseled
" 2	undetasseled	detasseled
" 3	detasseled	undetasseled
" 4	undetasseled	detasseled
" 5	detasseled	undetasseled
" 6	undetasseled	detasseled
" 7	detasseled	undetasseled
" 8	undetasseled	detasseled
" 9	detasseled	undetasseled
" 10	completely detasseled	
" 11	undetasseled	detasseled

Harvesting

Harvesting was begun when the ears were almost dry. Before harvesting, the vacant spaces between hills 50 and 51 in each row in both lots were marked by stakes to prevent the mixing of the harvest from the detasseled plants with that from the undetasseled. The harvest from each check row was put in a single pile. The harvest from each half-row was piled at the head of the row, then husked and allowed to dry for some time. The harvest from each half-row was weighed separately. The harvest from each check row was weighed as a whole.

EXPERIMENTS AND RESULTS

Germination

In spite of the heavy rain that followed the first planting a fair percentage of germination was obtained. A majority of the missing hills was noted to be in the eastern part of the field. This side is rather low, consequently was soaked on rainy days. The plants in this side of the field were small and lacked vigor. The plants in both lots suffered from the severe rainy weather which prevailed, many seedlings dying or showing poor growth. As a result, missing hills were noted and a marked decline in vigor of the seedlings was observed. But after some time the plants recovered in spite of the adverse weather conditions. Cultivation greatly helped in the recovery of the plants.

Field observations

The first planting was done on June 2, 1930 in the ear-to-the-row lot. On June 7, the ordinary planting was done. The field had been planted the preceding year to sugar cane. When the field was plowed it was very weedy. The corn seedlings were scarcely 30 cm. high when a new crop of weeds came up and covered the field. Because the plants were so small that hilling could not be done the field was weeded by hoeing. In spite of all the cultivation and care some parts of the field were weedy at the time of harvesting. This made harvesting difficult.

The first flowering was noted about fifty days after planting.

In the second planting more favorable weather conditions prevailed. A marked improvement in seedling vigor was observed in the second planting. In the eastern side of the field where the plants had hardly reached the height of 1.5 meters because of poor drainage, the plants now showed marked improvement. They were all vigorous and some reached as high as 3 meters. But, although favorable weather conditions prevailed at the beginning of the second planting, missing hills were again evident. A good percentage of germination, however, was obtained. The second planting was done on May 27, 1931. Harvesting was begun on September 1, 1931 and lasted for about three weeks.

The almost continuous rain, sometimes accompanied by wind, which began on August 8, 1931 and lasted for about three weeks had a bad effect on the second crop. Fortunately, the ears were still green when the rainy days set in. The stalks were beaten down by the storm thus making harvesting quite difficult. But, a reasonably good harvest was obtained.

DISCUSSION OF RESULTS

First planting

Because of the difference in soil fertility, as shown by the check rows, the comparison of the yield of the different rows was made on the basis of probable or theoretical yield. The data in table 1 show that the average theoretical yield per plant of the non-check rows of the detasseled halves of rows was 48.44 grams in favor of the detasseled plants.

Because this difference is small it was thought that statistical treatment of the actual data obtained might help in showing whether or not this difference has a real meaning. It was found that no

essential difference in the figures exists. It was not expected, however, that the detasseled plants and the check rows would show marked differences in yield because they were given similar treatment.

The average theoretical yield per plant of the non-check rows of the undetasseled halves of rows was 41.31 grams. The average yield of the check rows in this treatment was 45.49 grams. The check, therefore, exceeded the yield of the non-check plants by 4.18 grams. Comparing the theoretical yield per plant of the non-check rows of the detasseled halves of rows in this test with the undetasseled halves a difference of 7.13 grams per plant in favor of the detasseled halves is found.

The average theoretical yield per plant of the non-check rows in the ordinary method of planting was 39.95 grams, and the theoretical average yield per plant of the check rows was 36.27 grams. That is, the treated plants had more yield than the untreated. For the undetasseled halves of rows in this same test the average theoretical yield per plant of the non-check rows was 34.76 grams, or 1.51 grams less than that of the check rows. In the ordinary method of planting the difference in the yield of the detasseled plants and the check rows was 3.68 grams.

In the ordinary planting the average theoretical yield per plant of the non-check rows of the detasseled halves was 5.19 grams greater than that of the undetasseled halves.

Using actual yield (table 2) in ear-to-row plantings it was found that the average yield of the detasseled plants was 48.06 ± 0.8588 grams per plant, those that were left untreated, 38.28 ± 0.8556 grams, the difference being 9.78 ± 1.212 grams per plant. That this difference is decidedly significant in showing the benefit of detasseling cannot be questioned because it is more than eight times its probable error.

Similar treatment was employed for the plants under ordinary method of cultivation and it was found that the treated ones yielded 36.67 ± 0.7914 grams per plant; and the untreated ones, 33.06 ± 0.9310 grams, the difference being 3.61 ± 1.26 grams. This difference is insignificant.

It would appear to be conclusive that detasseling exerts some beneficial effect in the ear-to-the-row method of planting corn.

The question may now be asked, to secure a higher yield which of the two methods is the better. In the detasseled plants the ear-to-the-row method of planting yielded 48.06 ± 0.8588 grams per

plant. The ordinary method of planting yielded 36.67 ± 0.7914 grams, a difference of 11.39 ± 1.24 grams. In the untreated plants the ear-to-the-row method yielded 38.28 ± 0.8556 grams per plant, the ordinary, 33.06 ± 0.9810 grams, giving a difference of 5.22 ± 1.3 grams. That these differences are significant in showing that in yield the ear-to-the-row method of planting was superior cannot be questioned.

Second planting

The results of the second planting are summarized also in tables 1 and 2 where the averages of the yields are given. In the ear-to-the-row test the average theoretical yield per plant of the detasseled halves was 68.87 grams (table 1); and that of the check was 68.18 grams, a difference of only .69 gram in favor of the detasseled plants. In the undetasseled halves, the average yield was 65.76 grams. The check exceeded the undetasseled plants by 2.42 grams. The detasseled half-rows exceeded the undetasseled by 3.11 grams. This increase of the detasseled over the undetasseled plants was 4.02 grams less than the increase in the first planting.

In the case of the ordinary method of planting corn the detasseled halves gave an average theoretical yield per plant of 54.88 grams, the check, 48.58 grams, or a difference of 6.30 grams in favor of the detasseled plants.

Statistical treatment of the actual yield of plants in the two lots similar to that used in the first planting showed again a decidedly marked advantage of the detasseling over non-detasseling. That the ear-to-the-row method of planting was superior to the ordinary method of planting may be clearly seen in table 2.

General discussion

Corn is a naturally cross-pollinated plant. It is said that 95 per cent of the corn plants are cross-pollinated. In this particular study the plants of the tasseled portions of the rows were more or less self-pollinated, or close-fertilized.

In self-pollination in corn the pollen from the male flowers, or tassel of a given plant falls upon the stigma, or silk of fiowers of the same plant. In close-pollination the pollen of the male flower of a plant falls on the female flower of another plant in the same row. In cross-pollination, on the other hand, the pollen from the male flower of one plant in a certain row is transferred to the female flower of another plant in a different row. The fact that on either side of the tasseled halves of rows were detasseled plants on which

there was no pollen supply the chances were that the plants were self-pollinated or close-fertilized. It cannot, however, be stated with assurance that those plants were purely self-fertilized for the reason that pollen from flowers of other plants from other undetasseled rows might have fallen on the silk of these plants, especially on windy days. The writer observed that when the plants were shaken, even slightly, to and fro by the wind, a cloud of pollen would fly off falling on plants as far away as the third row from whence the pollen came. However, the pollen grains of a corn flower when matured, will fall off without outside agency. There were more chances, therefore, for the tasseled plants to become self-fertilized than the detasseled ones.

The writer observed in the field that the ears produced by the detasseled plants, were, in general, larger than those of the undetasseled plants. A close examination of the results showed that there are cases in which the detasseled rows yielded more than the undetasseled rows in spite of the former having less number of plants in the rows than the latter.

In the case of the detasseled half-rows it can be stated with certainty that the plants were cross-fertilized because the tassels were removed immediately upon their emergence.

Results on the breeding of corn in Illinois as compiled by the United States Department of Agriculture show that detasseling increased the yield of corn. There has been reported an increased grain yield of one per cent as a result of detasseling. Instances, however, are cited in which the yields were reduced as a result of this practice. This can be made plain by citing the following results obtained in breeding corn in Illinois. The even-numbered rows on two breeding plots planted to two different varieties of corn, each containing 44 rows, were detasseled. Each plot, therefore, contained 22 tasseled and 22 detasseled rows. The result in one variety showed an average increase in favor of the detasseled rows of 1.6 bushels per acre the first year, 10.1 bushels the second year, and 9.3 bushels the third year, while the detasseled rows of the other variety yielded 5.9 bushels less than the tasseled rows in the first year of the test and 14.7 and 11.8 more the second and third years, respectively. From these results it is considered probable that even greater benefit would be obtained from a system in which the seed from both sire and dam is crossbred. The earlier work of the Illinois Station in this line carried on for the purpose of determining the value of detasseling in increasing the yield, altogether

aside from its value as a feature in breeding seed corn, led to the belief that if the practice is beneficial at all it is most likely to be so on poor soil or in dry seasons.

From the results of the present study this conclusion from the Illinois work does not seem to hold true in the College, for although the plantings in this work were made in the wet seasons and in a fairly rich soil suited to this particular plant, a significant increase in yield of the detasseled over the undetasseled plants was noted. This increase expressed in terms of percentage over the average yield of corn under Philippine conditions is about 11 per cent which means that if this advantage can be secured under practical field conditions it would represent an addition of about 94 kilograms shelled corn to the hectare. (Present average is 855 kilograms).

The data also show that planting corn by the ear-to-the-row method is beneficial in increasing the yield. The averages of the two plantings show an increase of 27.6 per cent in yield of the corn over the ordinary method of planting. Interpreted in terms of kilograms per hectare this increase would represent an amount somewhat in excess of 239 kilograms over the present average yield.

Just what causes this apparent advantage would seem to be an important question. The pertinent questions are these: (1) Is the cross-fertilization incident to the detasseling responsible for such increase? The data in both the first and second plantings would indicate that perhaps cross-fertilization is of value in securing higher yield, but if cross-fertilization influences yield, the ordinary method of planting corn may be expected to give an even higher yield. The contrary, however, was found in that the ear-to-the-row method which may be assumed to be more closely fertilized than the ordinary method gave a significantly higher production. (2) Does the detasseling itself induce higher yield? It is known in the case of other plants that pruning is of value and it may be that the same factor operates with corn. It cannot, however, be stated with definite certainty that this is the true cause. Definite conclusions can be drawn only after special experimental work. That detasseling and that planting ear-to-the-row are beneficial in securing higher yield were determined in the present work. But just what the causes are was not determined.

SUMMARY OF CONCLUSIONS

1. That in the ear-to-the-row method of planting the yield of the detasseled corn plants exceeded that of the undetasseled ones.

2. That in the ordinary method of planting the yield of the detasseled plants exceeded that of the undetasseled ones.

3. That the yield in the ear-to-the-row method of planting exceeded the ordinary method by very considerable margin.

REFERENCES

ANONYMOUS. 1906. Breeding corn and the prevention of breeding. U. S. Dept. Agric. Farmers' Bull. 267: 5–8.

MENDIOLA, N. B. 1914. Hybridization of corn. The Philippine Agriculturist and Forester 3: 165–177.

GOCO, LORENZO. Pedigree selection with the Native Yellow Flint corn. (Thesis presented for graduation with the degree of Bachelor of Agriculture from the College of Agriculture. 1921. Unpublished.)

MONTGOMERY, E. G. 1920. The corn crops. xvii + 347 p. 120 fig. New York: The Macmillian Company.

NISPEROS, PETRONILO M. Inbreeding the Native Yellow Flint corn. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. 1929. Unpublished.)

SALVA CRUZ, SEBASTIAN R. The yield effect of mass-selection for starchiness, flintiness, and good form in corn with and without artificial inbreeding. (Thesis presented for graduation from the College of Agriculture with the degree of Bachelor of Agriculture. 1921. Unpublished.)

SALVADO, SEVERINO. Inbreeding the Native Yellow Flint corn. (Thesis presented for graduation with the degree of Bachelor of Agriculture from the College of Agriculture. 1930. Unpublished.)

TABLE 1

Showing the average theoretical yield per plant of the detasseled half of row and undetasseled half, and the average theoretical check yield per plant

	FIRST PLANTING		SECOND PLANTING		AVERAGE	
	Ear-row	Ordinary	Ear-row	Ordinary	Ear-row	Ordinary
	grams	*grams*	*grams*	*grams*	*grams*	*grams*
Average theoretical yield per plant of detasseled half of row	48.44	39.95	68.87	54.88	58.66	47.42
Average theoretical yield per plant of undetasseled half	41.31	34.76	65.76	47.78	53.54	41.27
Average theoretical check yield per plant	45.49	36.27	68.18	48.58	56.84	42.43
Number of grams per plant by which detasseled half of row exceeded undetasseled half	7.13	5.19	3.11	7.10	5.12	6.15
Number of grams per plant by which detasseled half of row exceeded the check	2.95	3.68	0.69	6.30	1.82	4.99
Number of grams per plant by which undetasseled half of row exceeded the check	–4.18	–1.51	–2.42	–0.80	–3.30	–1.16

TABLE 2

Showing the average actual yield per plant of the detasseled and undetasseled plants and the check

	FIRST PLANTING		SECOND PLANTING		AVERAGE	
	Ear-row	Ordinary	Ear-row	Ordinary	Ear-row	Ordinary
	grams	*grams*	*grams*	*grams*	*grams*	*grams*
Average actual yield per plant of detasseled half of row	48.06 ±0.8588	36.67 ±0.7914	64.06 ±1.2655	52.11 ±0.9968	56.06	44.39
Average actual yield per plant of undetasseled half	38.28 ±0.8556	33.06 ±0.9810	63.67 ±1.6533	46.17 ±0.9979	50.98	39.62
Average actual yield per plant of check rows	47.14 ±3.0015	36.17 ±2.2528	68.80 ±4.9373	47.90 ±2.1989	57.97	42.04
Number of grams per plant by which detasseled plants exceeded undetasseled plants	9.78 ±1.212	3.61 ±1.261	0.39 ±2.082	5.94 ±1.411	5.08	4.77
Number of grams per plant by which detasseled plants exceeded the check	0.92 ±3.12	0.50 ±2.387	—4.74 ±2.008	4.21 ±2.4124	—1.91	2.35
Number of grams per plant by which undetasseled plants exceeded the check	—8.86	—3.11	—5.13	—1.73	—6.99	—2.42

ABSTRACT[1]

A study of the effects of commercial fertilizers on garden crops. CENON R. PAULICAN. (*Thesis presented for graduation, 1917, with the degree of Bachelor of Agriculture from the College of Agriculture* No. 389; *Experiment Station contribution* No. 967.)—The objects of the experiment were: (1) to find out whether the use of commercial fertilizers is economically worth while in growing pole lima beans (*Phaseolus lunatus*), dwarf sweet corn (*Zea mays saccharata*), long purple eggplant (*Solanum melongena*), native radishes (*Raphanus sativus*), Indian cucumber (*Cucumis sativus*), Simpson black seeded lettuce (*Lactuca sativa*), and native mustard (*Brasica alba*), on the College Farm, the soil representing the common type in the Philippines, during both the rainy and cool seasons; (2) to find the effects of commercial fertilizers, that is nitrogen, phosphorus, and potassium and determine which is needed most by this soil.

The study was carried on in two projects. The first project was carried on during the rainy season in a plot of clay loam soil divided into 48 lots, each lot 1 × 4 m. in dimension. Lettuce, cucumber, radishes, eggplants, sweet corn, and beans were used. Nitrate of soda, muriate of potash and single superphosphate were applied either singly or in combinations in eight different treatments. In the first treatment, 2991.5 grams of nitrate of soda were applied; 2250.0 grams of muriate of potash in the second treatment; 6425.0 grams of superphosphate in the third treatment; no fertilizer was applied in the fourth; 2991.5 grams of nitrate of soda and 2250.0 grams of muriate of potash in the fifth; 2291.5 grams of nitrate of soda and 6425.0 grams of single superphosphate in the sixth; 6245.0 grams single superphosphate and 2250.0 grams muriate of potash in the seventh and 2991.5 grams nitrate of soda, 6425.0 grams single superphosphate and 2250.0 grams muriate of potash in the eighth. The second project was carried on an adjacent lot during the dry season with the same treatments as in the first project.

The most important criterion considered in comparing the effects of the different treatments with fertilizer was the salable product. The value in pesos of the harvest of the untreated lot was the

[1] Abstract presented as part of required theme work in English 3a, College of Agriculture.

basis of calculating the gain resulting from the use of the fertilizer. Weekly growths were also recorded by the author for all the cultures under study to find the effects of these different treatments upon growth.

Summary of the results showed that: (1) Greater profit was obtained from lettuce with the use of nitrate of soda, muriate of potash, single superphosphate at the rate of 2,991.5 grams, 2,250 grams, and 6,425 grams per 100 square meters, respectively applied singly or in combination, than when no fertilizer was applied. The highest profit was obtained with the use of nitrate of soda and single superphosphate in combination. Single application of nitrate of soda ranked second and it also hastened the salability or maturity of the crop.

2. Complete fertilizer was found to be best for cucumber, potash-nitrate, second; and nitrate of soda, third.

3. Nitrate of soda was most profitable for eggplant.

4. For sweet corn, single superphosphate applied in the rainy season gave the highest profit and nitrate of soda, second.

5. Single superphosphate was most profitable for radishes in single application and nitrate of soda-muriate of potash combination, second.

6. For beans, muriate of potash was most profitable and single superphosphate ranked second in the production of pods.

7. Nitrate of soda applied singly or in combination with muriate of potash or single superphosphate proved to be the fertilizer for mustard, with the greatest profit from the nitrate of soda-single superphosphate application.

8. Nitrate of soda applied in the cool season was better for sweet corn than the single superphosphate.

9. Cucumbers thrived better in the rainy season than in the dry season and no fertilizer proved to be profitable during the dry season.

10. Muriate of potash was found to be the most profitable fertilizer for beans, single superphosphate, second in the rainy season, and nitrate of soda, second in the dry season.

The author recommended that:

1. For every 100 square meters 2,991.5 grams nitrate of soda should be used as fertilizer for lettuce, mustard, cucumber and eggplant.

2. Complete fertilizer of nitrate of soda, muriate of potash and single superphosphate is best for cucumbers.

3. Cucumbers should be grown during the rainy season.

4. For sweet corn and radishes, 6,425 grams single superphosphate should be applied per 100 square meters in the rainy season.

5. Pole lima variety of beans should be planted one by one and five-tenths meter apart. For every 100 square meters 2,250 grams of muriate of potash should be applied.

Abstract by Pablo S. Padilla

The transverse strength of structural bamboo. GREGORIO C. SANTOS. (*Thesis presented for graduation, 1917, with the degree of Bachelor of Agriculture, from the College of Agriculture No. 390; Experiment Station contribution* No. 968)—The object of the work was to determine the strength of bamboo canes of different diameters of different thicknesses, and of different durations, of curing. The strength of the thorny, structural bamboo (*Bambusa blumeana*) was compared with the thornless, non-structural bamboo (*Bambusa vulgaris*). An apparatus, using an ordinary platform scale and levers, was devised to determine the transverse strength of the bamboo.

The results of the work showed that the non-structural bamboo is as efficient when strength only is considered, as the structural bamboo. The average maximum load of the commercial structural poles was found to be 182.33 kilograms (401.13 pounds), with an average deflection of 13.69 centimeters, the average weight of the sections being 5.85 kilograms (12.87 pounds) and forty days the average number of days of curing. The average maximum load of the non-structural poles was 214.18 kilograms (417.20 pounds), with an average deflection of 16.8 centimeters, average weight of the sections, 6.68 kilograms (13.38 pounds).

The average commercial structural poles tested and cured for about 100 days had an average transverse strength of 311.6 kilograms (685.52 pounds), and an average corresponding deflection of 18.9 centimeters. These market poles had the average breaking load of 304.4 kilograms (669.88 pounds) with a corresponding deflection of 17.7 centimeters.

There was no correlation found between diameter and strength, or between weight and strength, or between thickness and strength.

---

[1] Abstract prepared as part of required theme work in English 3a, College of Agriculture.

Bamboos with the largest diameter and those with the greatest thickness and weight were found to have the greatest breaking strength. The bamboos with the smallest diameter gave the least deflection.

The deflection of the bamboo was found to be proportional to the load until the limit of elasticity was reached.

Abstract by Daniel M. Buñag

KERNELS

"CORN FROM THE SHEAVES OF SCIENCE"

Kernels of kalumpang (*Sterculia foetida* Linn.) contain 51 per cent oil.

The circumference of the barrel of a Berkjala sow whether taken from the heart girth, middle of body or at the level of the flank is closely associated with size of litter.

For chick feeding, shrimp meal is the best protein supplement, fish meal is second and meat scraps is third.

The best growth of young rice plant, variety Kinandang puti, in clay-loam soil was obtained when the soil contained 70 to 80 per cent saturation. Soil saturated with water was arbitrarily considered as 100 per cent saturation.

In pulverized tuff soil, the best growth and development of coconut seedling was obtained when fertilized with 156 grams of sulfate of ammonia per plant, or when supplied with 52 grams sulfate of ammonia, 885 grams horse manure and 114 grams superphosphate.

The fertilizer ingredients available from one ton of seeds of buboy (*Eriodendron anfractuosum* DC.) is valued at ₱36.44.

Starch of pong-apong (*Amorphophallus campanulatus* Roxb.) may yield 20 per cent alcohol by weight.

The safest method of storing corn is by storing shelled grains after drying thoroughly in perfectly dry containers (preferably cans). The containers should be closed air-tight after the corn is placed in them.

The results of tests on the relative efficiency of various anthelmintic agents in cattle and carabaos in the Department of Animal Husbandry of this College showed that none of the drugs commonly recommended for intestinal parasites is one hundred per cent efficient. In the matter of receptiveness to parasites differences among the animals were noted. In general, calves in good condition were not as likely to suffer from the effects of infestation as those that were not.

CURRENT NOTES

Another thing that struck modern investigators about sugar was the astonishing quickness of its absorption.

It is the quickest food stimulant there is, and a real food stimulant, not a narcotic like its former rival alcohol.

The athletes and trainers and coaches have now grasped and made use of this quick-burning fuel for the body engine. A generation ago sugar and sweets of all sorts were absolutely taboo on the training tables. Now the coaches find that they can build and shape up their men quicker, with less danger of breakdown or staling, on a diet rich in sugar, sweet fruits and ice cream, than they ever could on the old, rigid, unbalanced, almost sugar-free diets. Many Marathon runners, for instance, are now carefully supplied by their trainers with candy and sweet fruit juice during the last two or three miles of the race; and instead of finishing grim masks of grey agony, half dazed and staggering, to collapse the moment they cross the line, they now pass the judges in good form, with heads up and faces cheerful.

Sugar has also been found a most valuable life-saver, mixed with a little salt solution and washed blood corpuscles, and injected into a vein, after dangerous haemorrhage.

The Australian Sugar Journal, April, 1934

Don't forget—

(14) That eggs should not be stored for more than 6 days before incubation;

(24) That where electricity is available you can use a ruby-red bulb in the previously darkened brooder house to check an outbreak of toe-picking, etc. The light should be placed just above and in front of the hoppers;

(34) That dry picking is the best way to pluck fowls;

(49) That green food intended for fowls should not be fertilized with droppings less than a year old;

(61) Not to waste money buying special mineral mixtures, laying meals, rearing rations and spices. Iodine is unnecessary, and so is cod liver oil, if good rations are fed and direct sunlight is available;

(80) That fowls should sit on a comfortable perch, and not be made to cling to a thin round pole.—FROM 101 HINTS FOR THE POULTRYMAN.

Farming in South Africa, March, 1934

A bird no bigger than a good-sized bee, found in the Haitian highlands, is described in a new publication just issued by Dr. Alexander Wetmore, assistant secretary of the Smithsonian Institution. It is known as the Hispaniolan vervian hummingbird. In spite of its tininess it is quite pugnacious, as indeed most humming birds are, and does not hesitate to dart to the attack of birds as big as a mockingbird if it objects to their presence. Among the other remarkable birds found in Haiti, Dr. Wetmore and his companion, Frederick C. Lincoln, of the U. S. Biological Survey, found a species of woodpecker that lives in community "apartment houses" instead of in solitary dwellings, after the fashion of the woodpeckers familiar in the North.

Science, January 26, 1934

Although the cow is probably the most widely used source of milk for human food, many other species are likewise employed by man. Goats supply milk for the Arabs, South Europeans, Latin Americans, and the Spaniards. The camel supplies the Egyptians and the Arabs; the mare, the Tartars and the Mongols; and the reindeer, the Lapps and Eskimos. The inhabitants of Asia, especially those of India, milk the zebu, or Indian cow; and the Chinese and the Filipinos use the water buffalo. Sheep are milked in the Netherlands, in Greece, in Czecho-slovakia, in Italy, and in the Balkan States. The yak, belonging to the bison family, supplies the natives of Mongolia and Tibet, and milk from the llama, a relative of the camel, is used extensively in South America. However, in many countries even these substitutes for the cow are lacking. Under such conditions the tendency is to prolong the period of normal nursing, sometimes to an extraordinary extent; thus the mothers

in some Indian tribes, among the Eskimos, and the poorer Chinese and Japanese nurse their children four to six years, or even longer.

In recent years evidence has accumulated rapidly to show that milk contains substances indispensable to life.

The Journal of the Department of Agriculture of South Australia, February, 1934

In a number of countries, including Sweden, Czechoslovakia, Russia, Rumania and the United States, there has in recent years been a definite movement in favour of this test [the physiological method (growth tests) of testing soil] in consequence of the success it has met with in Prussia, where there are now large scale testing stations, testing upwards of 2000 soils (in 25,000 pots) annually, that are run by an organization started 7 years ago and financed by the farmers themselves.

International Review of Agriculture (Rome), January, 1934

COLLEGE AND ALUMNI NOTES

Mr. George Murphy, a brother of Governor General Murphy, accompanied by Mr. and Mrs. Jose P. Melencio, Mrs. Agustin Liboro and Misses Helen D. Bennett and Conchita Sunico visited the College on June 1. They were shown around the College nursery, Experiment Station, Animal Husbandry Department, Agricultural Chemistry Department and the U. P. Sugar Mill by Dr. N. B. Mendiola, Head of the Department of Agronomy.

Dr. Silverio M. Cendaña, instructor in entomology, returned to the College on June 11, after an absence of about three years as a U. P. fellow in the University of California. In addition to an M.S. and a Ph.D. degree, he brought back with him propagating material of seven varieties of commercial figs, four varieties of olives, fourteen varieties of dates, and various ornamental California plants to add to the plant-introduction nurseries of the College. Doctor Cendaña speaks enthusiastically of the Berkeley and Riverside communities he was privileged to live in while abroad.

Mr. José Agudo of the Agusan Coconut Company on a recent visit to the Campus told the Department of Animal Husbandry staff that castrating female cattle, or spaying has been used regularly to

great advantage on the San Miguel Estate, Tayabas and the Bukidnon Ranch, Mindanao. There are one thousand spayed cows on the Bukidnon Ranch ready for marketing.

Mr. Saji Alfad of Bud Bayog, Jolo, Sulu visited the College on June 6. He is at present the nursery-man of Mrs. Lorillard Spencer, founder of the Willard Straight School in Jolo. His main interest was in the nursery practices of the College, especially in connection with the rapid propagation of fruit plants. According to Mr. Alfad, their nursery is distributing planting materials of fruit plants, free of charge, as a part of the work of Mrs. Spencer's school.

A group of women from the Bureau of Prison Correctional Institute for Women under the leadership of Dr. Cesarea M. Goduco, Matron of the institute, visited the College on June 9. Their purpose in coming was to obtain planting materials for the institute and to visit the different places of interest in the College.

Dr. Alexander Gordon, B.S.A., '24 was a recent Campus visitor. Doctor Gordon is with Ynchausti and Co. as agricultural adviser in connection with the company's sugar interests in Occidental Negros. He was in Manila to join a party sponsored by the Chinese Chamber of Commerce on a Good Will trip to Amoy, China.

Mr. Claudio G. Arellano, B.S.A., '30 now in charge of the management of range cattle and carabaos of the Iwahig Penal Colony, Palawan had items of interest for his old instructors in the Department of Animal Husbandry when he visited the College not long ago. He said the outline made by Dean B. M. Gonzalez for the management of range cattle is giving very satisfactory results. He also gave the cheering report that the breeding bulls consisting of two Indian Buffaloes, two grade Herefords and one Holstein purchased from the Department of Animal Husbandry about two years ago not only have done well but have sired good looking progeny numbering about sixty-four. Mr. Arellano while here was interested in learning the technique used in the Department for spaying cows not needed for breeding purposes.

Mariano Pamintuan '33 who is at present farming in Angeles, Pampanga visited the College on June 7. He conferred with Mr. Vicente B. Aragon of the Department of Agronomy about crop diversification work on his farm. His greatest problem, he said, is

to persuade the farmers to plant other crops than sugar cane. At present he is planting peanut, soybean, corn, upland rice, cassava and tobacco in his fields where sugar cane was formerly planted. He obtained his planting materials from the College.

In the "Abstracts and reviews" section of the *Lingnan Science Journal* April, 1934 published by Lingnan University, Canton, China appear reviews of two articles by Doctor Pendleton, head of Department of Soils. One article was "Notes on the geology of Leichan Peninsula, Kwantung"—from *Bulletin of Geological Society* China, the other was "A reconnaissance soil survey of a portion of Kwantung Province." *Soil Bulletin* No. 6 published by the National Geological Survey of China.

In *Tropical Life,* March number is a note on and quotation from "Poultry for Eggs" by Conrado Uichanco which appeared under a longer title in September, 1933 PHILIPPINE AGRICULTURIST.

The usual opening Convocation was held in the Auditorium at eight o'clock, June 13. The faculty speakers were Dr. Manuel Manresa, Chairman of Committee on Social Affairs, Dean Gonzalez and Dr. N. B. Mendiola. Francisco Rizal Lopez a junior, spoke on student life. Judging from the response of the audience he touched on well known high spots. The College songs and yells under the leadership of Abel Silva, a senior, went off with spirit.

THE BICOL REGION [1]

FROM THE NOTEBOOK OF A SOIL TECHNOLOGIST [2]

That portion of southeastern Luzon, comprising the provinces of Albay, Sorsogon, Camarines Sur and Camarines Norte is a region apart from the rest of the Island, and from the rest of the Philippines. It seems to stand alone, something as the majestic Mayon, the pride of the Bicol provinces, stands alone and is unique. But though Mayon may be unique in form and isolation, it is only one of a chain of magnificent volcanoes; Bulusan, Malinao, Iriga, Isarog —to name the ones that are well known. Other groups of mountains, as that north of Sorsogon town, while more impressive than Mount Maquiling, seem to be nameless.

Not only is Mount Mayon magnificent, at times it is literally awful in its threats to the safety of the inhabitants in the villages about its foot. The broad mass of sand and broken blocks of lava that swept to the sea near Libog in 1903, and the flows, that are still hot, of broken lava which came well down the slope near Libog in 1928, indicate that the threats of the mountain may again be made good.

Typhoons, too, in the Bicol region are a great danger, bringing devastation nearly every year. Epidemic animal diseases have left their mark, resulting in the practically complete extermination of horses in the Albay and Sorsogon provinces. The absence of caretelas and carromatas on the highways makes motoring much pleasanter and safer than in other provinces. The excellent bus system, the best that the writer has found in the Philippines, provides cheap and convenient transportation for all, so the absence of horses seems to be no hardship.

The Bicolanos have been retreating from the economic pressure of the outside world, as Daraga and other towns have from time to time been forced to retreat from the often slow but irresistible spread of destruction from Mayon's crater. The mild and gentle Bicolanos are also retreating from the invasion of the Tagalogs and Ilo-

---

[1] General contribution from the College of Agriculture No. 407.

[2] Accompanied by H. M. Curran Jr., the writer made a rapid reconnaissance of the soils of the Bicol region in May, 1934. Elsewhere will appear a report upon the soils of the region, a study to be based upon the notes, the 75 soil samples, and the 300 photographs taken by the party.

canos, who are coming in from the northwest along the railway in the Naga Valley. The Bicolanos seem not to have developed the energy and aggressiveness characteristic of people where life is harder or industry more developed.

Geographically, the region is isolated, with neither highways nor railways connecting it with the rest of Luzon. While the railway lines have been extended at both ends, and the time of the connecting steamer trip is reduced to hardly more than two hours, the barrier to direct communication is still considerable. But in spite of the expensive and time-consuming transfers from rail to ship, and ship to rail, astonishing quantities of poultry and fish, the latter alive in tubs of water, or iced, are shipped daily to Manila from Naga and still more distant points. It is doubtless the amazing cheapness of all local products and labor that makes this traffic possible. When a purchaser with cash can be found, chickens sell for a few centavos each, and other produce in proportion. Day laborers receive 20 to 30 centavos a day, with no food nor other perquisites supplied.

Though for a long time the Bicol provinces have specialized in the production of abacá, the agriculture of the district is backward. While the hacienda system can hardly be considered dominant in the region, there are a number of extensive estates growing abacá. Competent observers have remarked that the backwardness of the region is seriously aggravated by the absentee landlords. The indifference or connivance of their agents has permitted to come into existence a pernicious system of division of produce and profits, and also night stealing of stripped abacá fiber, with certain dealers buying this stolen fiber at low prices. Fiber stripping is usually done on the share, the nominal division used to be one-third to the laborer, and two-thirds to the owner of the plantation. But now, even with the laborer receiving a considerably larger share of the fiber, because of the very low prices obtained for it, it is often impossible for him to make 50 centavos a day by this very hard work. One of the results of the low prices for abacá is that a considerable proportion of the stripping is crudely done with a serrated knife, a method by which more fiber can be stripped than with a smooth knife; thus the laborer can increase his daily earnings. It is reported that the poor dark fiber prepared with the serrated knife is exported to Japan for paper making.

The abacá of the Bicol region is a much smaller plant than that of Davao, the tips of the leaves of the former not reaching more than four or five meters in height. The crop is planted on both the lower slopes and on the steeper hills and mountains, with a half

shade of *ilangilang, dapdap,* or other taller trees. On distant hills the plantations of this type are not readily distinguished by a novice from the common culled forests or *parang* tracts bordering the cultivated lands of the Islands. Certain it is that this type of cultivation so well protects the soil from erosion that little occurs, unless very special conditions arise, as at Irosin, Sorsogon, where on last Christmas Eve at least 50 hectares of nearly level land, planted mostly to abacá, saturated after two weeks of heavy rains, almost bodily flowed out through a deep break, and on down through the edge of Irosin town, washing away about 75 houses, before finally dissipating its energy in spreading out over the rice fields.

Coconuts, while a much less important crop than abacá, have nevertheless, been planted in the last few years rather extensively in the same region as the abacá, that is, along the eastern coast on the lower slopes and about the recent volcanoes. In addition, there are some extensive plantings to the west, near Ragay Gulf, particularly on limestone soils, as at Pasacao, and at Jovellar.

The valley floors, especially in the vicinity of Naga, are planted to rice. The cultivation is anything but intensive. One crop a year is raised, and in a way that seems odd in comparison with the more generally used methods. The more or less continuous rainfall throughout the year, the frequently very poor drainage of the lowlands, and the long periods that the land remains idle but moist, allow a heavy growth of reeds and weeds, which must be disposed of before planting can be undertaken. The most common method of land preparation seems to be to roll the weeds and sedges several times with heavy wooden rollers. The roller, which is about 20 by 100 centimeters may be fluted, though more usually it is armed with numerous iron chisels, which project out radially about 10 centimeters from the face of the roller. These chisels are about 5 centimeters wide. The roller may be enclosed in a frame with the top and sides covered and with shafts that extend to the carabao. The driver rides, and several carabaos are hitched to the implement; or the rollers may be mounted in lighter frames, and drawn by one animal, the driver riding the leading one of several animals, each drawing a roller, and each animal tied to the roller ahead. After these rollers have been passed over the fields several times, and the weeds broken down and pressed into the mud, the usual rice field "harrow" is used to further puddle the soil and prepare it for planting. Since carabaos are very cheap and very plentiful, good animals being obtainable for around ₱10, a group of these animals may be

tied together, abreast, and driven round and round in a number of small circles in the rice field, treading the weeds into the soil and puddling it preparatory to planting.

On the hills which occupy approximately the western third of the region, the soils are for the most part shallow and are apparently much less fertile as well as being less watered. In this region, while there are coconut plantations, neither copra nor abacá are produced extensively. Caiñgin agriculture has long since destroyed the good forests, and left in its wake nearly worthless *parang* growth and *cogonals* of vast extent. This region has been rather inaccessible as a whole, and is often sparsely inhabited. This condition was aggravated by the infestation of the western hills by bandits during the first decade of the century.

But with the extension of good highways into the western hills, and the need for the production of food crops in place of copra and abacá for export, farmers are moving back into this region, and increasing the cultivated area there. The great need of this region is the development of methods of permanent agriculture and soil conservation which will permit the continuous cultivation of the hilly land without excessive erosion, together with the suppression of weeds, and particularly of cogon growth. It is encouraging to note the extent to which *ipilipil* (*Leucaena glauca*) is invading this western hilly zone, where it is already beginning to meet the need for fuel and poles. The *ipilipil* is dominating and eliminating the cogon and other *parang* weed growth, improving the soil and reducing the extensiveness of grass fires. Upland rice with its necessity for bare soil, somewhat loose on the surface, which is seriously exposed to the torrential rains soon after planting, continues to be the most important food crop in these hilly regions. To a stranger, one of the picturesque features of the planting of upland rice in Albay is the use of a long dibble pole, on the upper portion of which is mounted a meter's length of large diameter bamboo, cleverly fashioned into a clapper and sounding board, by which the skilled planter produces a fascinating rhythm of pleasing tone.

While much of the country has long been inhabited and cultivated, though indifferently, or the primitive types of cultivation have been given up and the land abandoned, there are other vast tracts, particularly in the north and northwest, which are still covered by virgin forests. One such forest lies between the valley of the Sipocot River on the south, and the valley of the Labo River on the north. Along the recently completed highway from the Sipocot railway station to Daet, in the Labo valley to the north, the homesteaders

and squatters are rapidly pushing in, taking up for agriculture not only the rough lands released after logging, but in many cases wantonly destroying vast quantities of timber in commercial forest stands—a very distressing waste of fine forest to enable the squatter to produce a few sacks of upland rice or corn, and a few vegetables. But abacá and copra do not make a good diet, and in the caingins at least some food can be raised for a few years, before the soil has been carried away by erosion or its fertility lost, or the weeds dominate the situation. It must be admitted that local prices for even first group timber are so low that there can hardly be an adequate appreciation of values. Sawn narra, even in the larger towns, costs but seven centavos a board foot—not more than poor, fourth group timber here in Los Baños.

The forest ranger may prosecute the *caiñginero,* destroyer of the forests, but the difficulties and expense to which the Bureau of Forestry is put to make effective the conviction of the guilty, make it impossible for that organization to do what it is expected to do in the conservation of the Islands' extremely valuable and important forest resources. The Insular Government should give much more support that it does to this very important Bureau. In some cases, as along the Daet road, national parks or other special reserves have been established and they aid in the conservation of some of the best forests, but this plan has its serious limitations. On the whole, the forest destruction is so serious along the new highways that one regrets to see any more highways constructed through the forest lands, however much the roads are needed for the general development of the Philippines.

Because of the recent opening of the highways, especially those to the mines and to the railway, and because of the mining boom in the Paracale district to the northwest, Daet, the capital of Camarines Norte, is experiencing new vitality and recovering from its isolation, in spite of the very low prices for the staple products. The earlier dependence of this town upon water transportation for contact with the outside world is shown by the numerous, old massive warehouses at the town's port, Mercedes. The wharf was at one time dominated by the now crumbling old fort.

While the Bicol region is one that has long had a specialized agriculture, as a whole it is one that is very inadequately developed. The potentialities as yet unused are indicated by the statement of a scientific observer, long a resident in Albay Province, that the four

Bicol provinces could support six million people at a better standard of living than it is now supporting the present population of about one million.

The Bicol region is a marvelous demonstration of the interaction of geological and climatic forces in the development of tropical soils—it is a life-size laboratory of soil formation. The results of the experiments that have been going on through the centuries may be read while you run—at 50 kilometers an hour over excellent roads.

ROBERT L. PENDLETON
Of the Department of Soils

EDUCATIONAL NEEDS

Demands for lower taxes has led some people to advocate drastic curtailments in educational opportunities of the youth of today. Perhaps only a few have this idea; nevertheless, these few may influence others and the state will suffer from the results.

The youth of today will cause the world's wheels to turn tomorrow, and imagine conditions forty years from now if education should be lessened beyond the desirable minimum. School expenses can be and are being reduced, but one thing should not be overlooked. A serious reduction of school budgets will do away with the better teachers and will lessen the strength of the curricula and standards of achievements being offered to pupils coming from all kinds of cultural and vocational environments.

Our national and state governments will attempt this year to lower government expenses, but may we all give the essential things the fullest consideration before we advocate their drastic reduction. Some things, like road construction, can be deferred if necessary, but time goes on and the highways of opportunity and education for the youth of the country should be kept in full operation.

The Purdue Agriculturist (Purdue University) February, 1933

In an American university, out of 12,000 students, 8,000 are working at the same time to pay their fees.

The New Zealand Dairyman

STUDIES ON THE MORPHOLOGY OF THE MELIACEAE: II. STERILITY IN SANTOL, SANDORICUM KOETJAPE (BURM. F.) MERRILL [1]

JOSÉ B. JULIANO
Of the Department of Plant Physiology

WITH TWO PLATES AND ONE TEXT FIGURE

A santol tree, *Sandoricum koetjape* (Burm. f.) Merr., which began flowering in 1930, but has never produced any fruit, was brought to the attention of the writer by its owner in March, 1932. An enormous number of flowers are formed yearly and fall off after reaching maturity. After vainly awaiting for three years or more the development of even a single fruit from his tree, Dr. Valente Villegas of the College of Agriculture, its owner, decided to have it top-worked.[2] At the request of the writer half of the tree was left untouched and signs of floral bud development were noted on December 27, 1932.

With the hope of determining morphologically the cause for this apparent sterility in this particular santol tree, collections of young inflorescences as well as flowers in different stages of development were made periodically from February 9 to March 13, 1933. The material was fixed in the laboratory with the use of formalin-acetic-alcohol (70 per cent) prepared according to the formula given by Chamberlain (1932), treated in the usual fashion, and embedded in paraffin. Sections, five to ten micra in thickness were obtained and most of them were stained in Heidenhain's ironalum haematoxylin with orange G dissolved in clove oil as a counterstain. Delafield's haematoxylin-Safranin combination was also employed to advantage.

INVESTIGATION

Macroscopical

Observations made throughout the blooming period of the tree in 1932-1933 revealed clearly the following outstanding facts. First, the flowers were formed in astonishingly large numbers (pl. 2,

---

[1] Experiment Station contribution, No. 971. Read before the Los Baños Biological Club, December 14, 1933. Received for publication, January 16, 1934.

[2] The top-working was done by students taking a course in Tropical Pomology under the supervision of Dr. Leon G. Gonzalez of the Department of Agronomy. Considerable amount of success was achieved with scions from naturally fruiting trees growing in the vicinity of this particular sterile santol plant.

fig. 8), and these attained normal size. Second, these flowers did not have their corolla lobes or petals outspread at the time of maturity of the stigmas and anthers, but these remained imbricate even after the flowers had fallen from the tree (fig. 1A). The stamens and the stigmas, therefore, remained permanently enclosed by the petals. This case is, in the writer's opinion, the first to be recorded where flowers of this tree have become cleistogamic in nature although their internal organs are well developed. Knuth (1906) describes this kind of flower as hemi-cleistogamic in that it opens a little although the petals remain overlapping each other (fig. 1A). Cross pollination, therefore, is difficult if not impossible. This floral be-

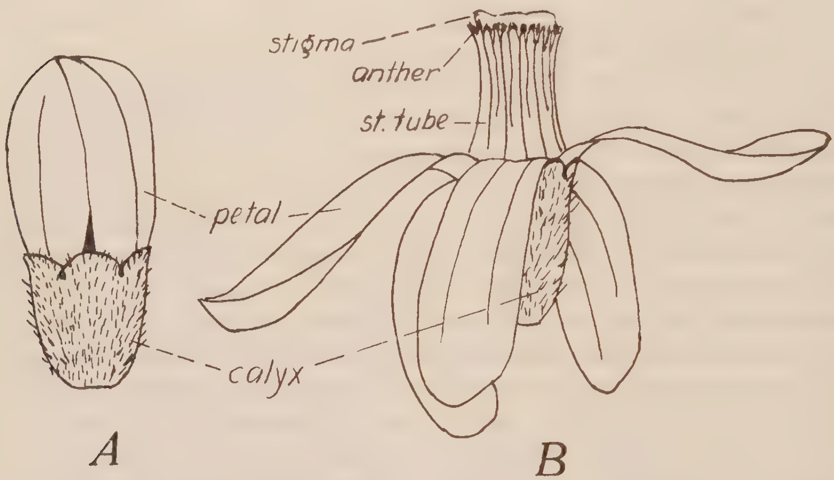


Fig. 1.—*A*. Hemi-cleistogamic flower. *B*. Normal flower at anthesis. Enlarged about five times their natural size.

havior affords a beautiful contrast with that obtaining in chasmogamous flowers produced by normally fruiting santol trees (fig. IB).

Third, at the time the flowers fall from the tree, and even after they had been lying on the ground for a day or two, their anthers were hermetically closed and their microspores or pollen grains undehisced (pl. 2, fig. 10). This condition renders self-pollination or autogamy difficult. On the contrary, flowers from santol trees normally producing fruits have their microspores dehisced (Juliano, 1934) at anthesis (chasmogamy) which takes place between eight and nine o'clock in the morning (pl. 2, fig. 11).

That fungi might have played a rôle in preventing these flowers from opening is impossible, for on January 13 and February 1, 1933,

respectively, the lower branches of this tree were sprayed with Standard Bordeaux mixture.[3] The sprayed flowers showed no sign of opening, and fell from the tree at maturity.

An attempt to induce the opening of these flowers with the use of artificial light at night was frustrated as the 1000-watt bulb used burned out before the desired results were in sight. Neither was artificial pollination accomplished during the blooming period in 1932-1933, so that these two points can not be discussed here.

Microscopical

Floral organs. The sequence of development of the floral organs in this particular tree is like that reported for trees normally producing fruits (Juliano, 1934); the floral organs arise in the following order: sepals, petals, stamens, carpels and disc.

Megasporange and megagametophyte. The history of the megasporange and megagametophytic development in this particular plant is similar to that reported by Juliano (1934) for santol trees normally producing fruits. The megasporanges are ten in number, two in each of the five loculi or cells in the ovary. The individual megasporange possesses two distinct integuments, the outer and inner integument, which arise basipetally. Each of the anatropous megasporanges is held by a long funiculus (pl. 1, fig. 4) and this megasporange hangs downward with its micropyle superior. Very early a hypodermal cell, functioning as an archesporium, arises from the summit of the nucellus of the anatropus megasporange. This archesporium gives rise to an outer primary parietal cell and an inner megaspore mother cell by a single periclinal wall. The primary parietal cell together with the epidermal and hypodermal cells of the nucellus (pl. 1, fig. 1 and 2) form an extensive parietal tissue which buries the megaspore mother cell way deep in the chalazal end of the megasporange.

Usually, one megaspore mother cell differentiates in the nucellus (Juliano, 1934), but a rather rare occurrence of two megaspore mother cells (pl. 1, fig. 2) is here reported for this sterile plant. This may not have much morphological significance, but its presence is worth noting as this is the first case of this nature so far determined. It seems clear that the two megaspore mother cells arise from two independent archesporial cells which divide periclinally to form two independent megaspore mother cells inside and two outer primary parietal cells outside. The megaspore mother cells are elongated, one

---

[3] Thanks are due Mr. Emiliano F. Roldan of the Department of Plant Pathology for supervising the spraying work.

of which possesses a much larger nucleus than the other. At any rate, even if more than one megaspore mother cell develops and differentiates in the nucellus, only one of them forms a normal embryo sac.

The megaspore mother cell by two successive periclinal divisions forms a linear tetrad of megaspores, the lowermost of which becomes functional, while the three micropylar megaspores degenerate. A normal seven-celled megagametophyte so often reported in many Angiosperms as well as in the normally fertile santol tree is developed here by the functional megaspore.

The mature megagametophyte shows also the presence of evanescent antipodal cells, a well-defined egg apparatus consisting of two synergids and one megagamete (pl. 1, fig. 3), and two polar nuclei (pl. 1, fig. 5). The megagamete usually lies between the two synergids and possesses a small nucleus embedded in a very thin peripheral cytoplasm at its apex. A big vacuole occupies nearly the whole cell. The synergids are large, very much elongated and pear-shaped structures with very dense cytoplasm. At the base of the synergids is the filiform-apparatus. The nuclei of the synergids are almost always situated around the middle portion of the thick cytoplasm and are much larger than that found in the megagamete. Sometimes a vacuole is present, and this appears near the apex of the synergid.

The polar nuclei usually remain very near the vicinity of the egg apparatus and these fuse later. Fusion of the polar nuclei often takes place after the flowers have fallen from the tree (pl. 1, fig. 3) and may divide once without being fertilized (pl. 1, fig. 7).

During his examinations of his material, a very peculiar embryo sac (pl. 1, fig. 5) was noted by the writer. This particular section was secured from a fallen flower. In this sac are shown a well-developed egg apparatus and two polar nuclei. The megagamete is more or less pear-shaped and possesses a thin peripheral cytoplasm in which is embedded its single nucleus at the region farthest from the micropyle. A large central vacuole occupies nearly the whole cell. The synergids are much smaller, oval in shape, and gradually narrow at the region of the filiform-apparatus. Each is filled with dense cytoplasm and distinct nucleus. The polar nuclei lie side by side, directly under the egg apparatus and not far from it. The antipodals are degenerated and no trace of them could be found. At the chalazal region is a distinctly large, ovate cytoplasmic vesicle (pl. 1, fig. 5) which occupies nearly half of the sac. In this vesicle are found floating in its cytoplasm fourteen nuclei. At its center is a vacuole. The writer is inclined to believe that this peculiar structure, the vesicle,

develops from the lowermost megaspore, the nucleus of which undergoes free nuclear divisions. This megagametophyte fails to differentiate its own cells so often encountered in other mature female megagametophytes. The egg apparatus together with the two polar nuclei are derived from the upper megaspore, and the evanescent antipodals are degenerated. This is what is to be expected as simultaneous development of two lower megaspores were noted by Juliano (1934) in megasporanges from trees normally producing fruits.

That this vesicle may be of antipodal origin is too improbable to consider in this fruit tree inasmuch as the antipodals are evanescent and ephemeral structures in the embryo sac, and these are absent at the time of fertilization (Juliano, 1934). In some plants like *Musa* sp. (White, 1928 and Juliano and Alcala, 1933), there is the formation of endosperm vesicles, multinucleate structures, similar to that found in this abnormal embryo sac of this sterile santol tree. Inasmuch as the polar nuclei are still present and much more unfused, the possibility that the vesicle reported here is endospermous in character is eliminated.

Degenerations of the female gametophyte described by Juliano (1934) have also been noted here, and these usually take place any time from the tetrad stage up to maturity of the sac. If degeneration fails to take place in the sac of the megasporange and normal, functional megagametes and fusion nuclei are developed, then degeneration will take place later owing to lack of fertilization (pl. 1, fig. 7). Because of the inability of the male gametophyte to effect fertilization, the functional contents of the sac meet a natural death. This degeneration which also takes place in *Citrus* (Osawa, 1912), *Daphne* (Osawa, 1913), *Prunus* (Bradbury, 1929) and *Albizzia* (Maheswari, 1931) is characterized by an increase in the density and amount of cytoplasm of the cells and by an irregular outline of the nuclear membrane. Their nuclei and the cytoplasm finally take a dense black stain and sink into an irregular structureless mass. The megagamete disintegrates and the synergids condense into masses of highly colored bodies, their filiform-apparatus being the last to disappear (pl. 1, fig. 7). Simultaneous with the disorganization of the contents of the embryo sac there takes place a deposition of an abundance of starch grains in the sac (pl. 1, fig. 4 and 7) so extensively investigated by Dahlgren (1927) in many Angiosperms.

As the contents of the embryo sac degenerate, the whole megasporange undergoes collapse and shrinkage (pl. 1, fig. 4). Its inner integument is the first to disorganize, and the nucellus ultimately becomes separated from the outer integument. The nucellus which

is now very thin due to the marked enlargement of the embryo sac also disintegrates and shrivels and this is followed by the outer integument. The combined degeneration of the outer integument and the nucellus is responsible for the collapse and shrivelling of the megasporange.

Microsporange and microspores. The development of the microsporange and the microspores is normal, and is similar to that obtaining in trees normally producing fruit (Juliano, 1934). An archesporium of one to three hypodermal cells differentiates on each lobe of the anther, and these archesporial cells early divide periclinally to form an outer layer of primary parietal cells and an inner layer of primary sporogenous cells. The outer layer of primary parietal cells by periclinal divisions form from four to five layers of parietal tissue, the outermost layer of which functions as the endothecium (pl. 2, fig. 10) and the innermost layer as the tapetum. The tapetal cells as well as the parietal cells below the endothecium usually disappear as the anther matures.

The primary sporogenous cells function as the microspore mother cells, and by two successive divisions each forms the microspores which become trinucleate very early. The mature microspores contain an abundance of food granules, two distinct coats, and three nuclei (pl. 1, fig. 6). Many of the microspores in the mature anther are empty and shriveled; this is due to the degeneration of their nuclei or failure to provide themselves with food granules (Juliano, 1934).

When the flower reaches maturity or just before it falls from the floral cluster, each of its anthers possesses a distinct epidermis, below which is the well-developed endothecium with its characteristic rod-shaped thickenings (pl. 2, fig. 10). A few cells of the parietal tissue may persist, and as the cells of the adjacent sporanges have already disappeared they merge together to form a single cell. Lobation of the anthers may not disappear by the fusion of the two adjacent sporanges. The anther wall covering the two adjacent sporanges remain connected at the stomium so that the microspores are never dehisced. This condition is a direct contrast with that obtaining in flowers from santol trees normally producing fruits (pl. 2, fig. 11) where the anthers are opened at the time of anthesis.

This hermetically closed condition of the anther may persist even if the flower has fallen from the floral cluster (pl. 2, fig. 10). Sometimes the anther walls break at the stomium and release the microspores when the flower is already on the ground, but under such a condition there is a very slim chance for the pistil to develop as

the flower is cut off from the supply of nutrients much needed in the development of fruits. Besides, at the time the flowers are on the ground the microspores which are normally developed, are undergoing degeneration (pl. 1, fig. 6) and no longer show signs of fertility. Their nuclei stain intensely and lose that characteristic appearance of vitality.

A great many species of plants possess cleistogamic flowers in which the anthers dehisce their microspores (chasmantherous). These microspores are shed on to the stigma where they germinate as is true of *Vicia angustifolia* (Knuth, 1906). In this sterile santol tree under discussion the anthers never shed their microspores so that pollination is impossible.

In other cleistogamic flowers the anthers do not dehisce their microspores at all, a condition similar to that obtaining in this sterile santol tree. Unlike the microspores of this tree, the microspores of those other cleistogamic flowers germinate in the anthers and their tubes are obliged to penetrate the anther walls (cleistantherous) before they can reach the stigma. This is true of *Oxalis acetosella* (Von Mohl, 1863) where the tubes grow out of the anther in an irregular tangle from both sides and from the tips of the anthers. These tubes creep here and there among the anthers and styles, and for the most part climb up to the latter to reach the small stigmas. In *Impatiens Noli-tangere*, Knuth (1906) says that although the anthers dehisce markedly, the microspores germinate within the anthers with the production of very numerous tubes which unite the anthers and the stigmas.

Von Mohl (1863) also noted that in *Specularia perfoliata* the undehisced microspores spread their tubes from their anthers. These tubes take a regular course through the spaces existing beween the anther and the style as well as between the anthers. These tubes are tough and if the anthers are pulled away from the styles, these tubes are not torn across but they remain connected with the stigmas by their extremities, and the microspores from which they spring are drawn out of the anthers.

A much more interesting development of the microspores is found in cleistogamic flowers of *Lamium amplexicaule* (Knuth, 1906). In this species the microspores in the closed flowers send out their tubes to the stigma, either after escaping from the dehisced anthers or while still in the anthers that remained closed. In the latter case the tubes break through the anther wall and consequently fruits are formed. It is apparent that among cleistogamic flowers fruits are

usually developed in one way or another, a condition not obtaining in this particular sterile santol tree.

The peculiar behavior exhibited by the anthers and microspores of this sterile santol tree is such that pollination becomes an impossibility. The microspores are not dehisced and never germinate inside the anthers. The presence of a well-developed endothecial layer in the anther will surely impede the progress of the tubes if the microspores ever germinate in the anthers. In other words, the sole cause for the non-setting of fruits in this sterile santol tree is the inability of the microgametophyte to reach the fertile megagametophyte in the same flower (autogamy).

The corolla. Unlike the corolla lobes of flowers of *Myrmecodia echinata* Gaud. (Burck, 1883), *Unona coelphlaea* Scheff., *Artabotrys suaveolens, Artabotrys Blumei, Goniothalamus giganteus* Hook. & Th., and *Cyathocalyx zeylanica* (Burck, 1890) where the petals are completely fused, the corolla lobes of the flower of this santol tree are free (fig. 1A). At maturity of the stamens and stigma the petals remain imbricate, but towards the calyx rim they tend to leave small apertures between the two adjacent lobes. This is in direct contrast to flowers from a normally fertile santol tree (fig. 1B); here, the petals actually diverge from each other and thus expose their sex organs. This movement is effected by the bending of the petals just above the calyx rim.

Microscopical examinations of longitudinal as well as transverse sections of the petals from the two kinds of flowers do not reveal any material difference in the number of layers and anatomical structures of the mesophyll cells between the epidermal layers. The only apparent difference is detectable in their relative thickness. The petal of the flower which opens at maturity of its sex organs is thicker than that from the flower which remains closed. The increase in thickness of the petals is due mainly to the increase in size of the individual cells of the mesophyll, and this finds expression, perhaps, in the opening of the petals (pl. 2, fig. 9). What factor or factors are responsible for a physiological difference so conspicuous in the petals of these two kinds of flowers is beyond the scope of this investigation.

SUMMARY

A case of sterility in santol, *Sandoricum koetjape* (Burm. f.) Merr., is here described. This particular tree since 1930 yearly has developed numerous flowers which fall off after attaining maturity, and consequently has not produced a single fruit.

The petals of the individual flower fail to open so that the normally developed male and female organs remain enclosed by the corolla. It is believed that this is the first case to be recorded where flowers of this fruit tree have become cleistogamic in nature. No morphological difference is detectable in petals from flowers which remain closed and those which open at maturity, so that the probable cause for the cessation of the opening of the petals of flowers from this particular sterile tree is physiological rather than morphological in nature.

The female gametophyte is normal and follows that reported for trees which normally produce fruits. The megagamete in the functional megasporange from each of the loculi of the ovary is never fertilized, and the flower which does not develop any further, falls off from the floral cluster.

The male gametophyte development follows the conventional and the microspores are trinucleate. These microspores which are hermetically sealed in the anthers even after the flower has fallen from the floral cluster do not germinate under such a condition. Consequently, pollination is prevented. Degeneration of the microspores was noted before and after the flower falls from the tree.

LITERATURE CITED

BRADBURY, D. 1929. A comparative study of the development and abortive fruits of *Prunus cerasus*. Amer. Jour. Bot. **16**: 525-542. *Pl. 51-54; fig. 1-4.*

BURCK, W. 1883. Sur l'organisation florale chez quelques Rubiacées. Ann. Jard. de Bot. Buitenzorg **3**: 105–120.

BURCK, W. 1890. Über Kleistogamie im weiteren Sinne und das Knight-Darwin'sche Gesetz. Aus dem hollandischen Manuscripte übersetzt von Paul Herzsohn. Ann. Jard. de Bot. Buitenzorg **8**: 122–164.

DAHLGREN, K. V. D. 1927. Über das Vorkommen von Starke im Embryosacke der Angiospermen. Ber. d. Deutsch. bot. Gesells. **45**: 374–379.

CHAMBERLAIN, C. J. 1932. Methods in plant histology. xiv + 416 p., 140 fig. Chicago: The University of Chicago Press.

JULIANO, J. B. 1934. Studies on the morphology of the Meliaceae: I. *Sandoricum koetjape* (Burm. f.) Merr. The Philippine Agriculturist **23**: 11–48. *Pl. 1–6; fig. 1.*

JULIANO, J. B., AND P. E. ALCALA. 1933. Floral morphology of *Musa errans* (Blanco) Teodoro var. *botoan* Teodoro. The Philippine Agriculturist **22**: 91–126. *Pl. 1–5; fig. 1.*

KNUTH, P. 1906. Handbook of flower pollination. Vol. 1. xix + 382 p., 81 fig. Oxford: Clarence Press. Translated by J. R. Ainsworth Savis.

MAHESWARI, P. 1931. Contribution to the morphology of *Albizzia lebbek*. Jour. Indian Bot. Soc. **10**: 241–264. *Pl. 1–3; fig. 1–3.*

MOHL, H. VON. 1863. Einige Beobachtungen über dimorphie Blüten. Bot. Ztg. 21: 309–315, 321–328.

OSAWA, I. 1912. Cytological and experimental studies in *Citrus*. Jour. College of Agric., Imper. Univ. (Tokyo) 4: 83–116. *Pl. 8–11; fig. 1.*

OSAWA, I. 1913. On the development of the pollen-grain and embryo-sac of *Daphne* with special reference to the sterility in *Daphne odora*. Jour. College of Agric., Imper. Univ. (Tokyo) 4: 237–264. *Pl. 25–27; fig. 1–3.*

WHITE, P. R. 1928. Studies on banana: an investigation of the floral morphology and cytology of certain types of the genus *Musa* Linn. Ztschr. Zellforsch. u. Mikroskop. Anat. 7: 673–733. *Fig. 1–130.*

EXPLANATION OF PLATES

Parts of the flower are designated as follows: endosperm nucleus (*en*), embryo sac (*es*), funiculus (*f*), fusion nucleus (*fn*), megagamete or egg (*me*), megasporange or ovule (*mg*), nucellus (*n*), outer integument (*oi*), starch grains (*sg*), synergid (*sy*), and vesicle (*vs*).

PLATE I

Fig. 1. Longitudinal section of the nucellus showing the megaspore mother cell below and the two daughter cells derived from the first division of the primary parietal cell. × 530.

Fig. 2. Showing two megaspore mother cells. × 530.

Fig. 3. Showing egg apparatus and fusion nucleus from a fallen mature flower. × 445.

Fig. 4. Diagram of a longitudinal section of a megasporange from a fallen flower undergoing degeneration. × 56.

Fig. 5. An abnormal embryo sac derived from the two lower megaspores. × 270.

Fig. 6. Microspore from a fallen flower undergoing degeneration. × 445.

Fig. 7. Degenerated embryo sac showing synergids, megagamete, two endosperm nucleus, and abundant starch grain. × 490.

PLATE II

Fig. 8. Showing mature inflorescence with closed flowers, photographed March 13, 1933. About half natural size.

Fig. 9. Portion of a longitudinal section of a petal from a normal flower at anthesis showing mesophyll cells. × 93.

Fig. 10. Showing transverse section of mature undehisced anthers from hemicleistogamic flower collected on the ground. × 93.

Fig. 11. Showing transverse section of mature dehisced anther from normal flowers at anthesis. × 93.

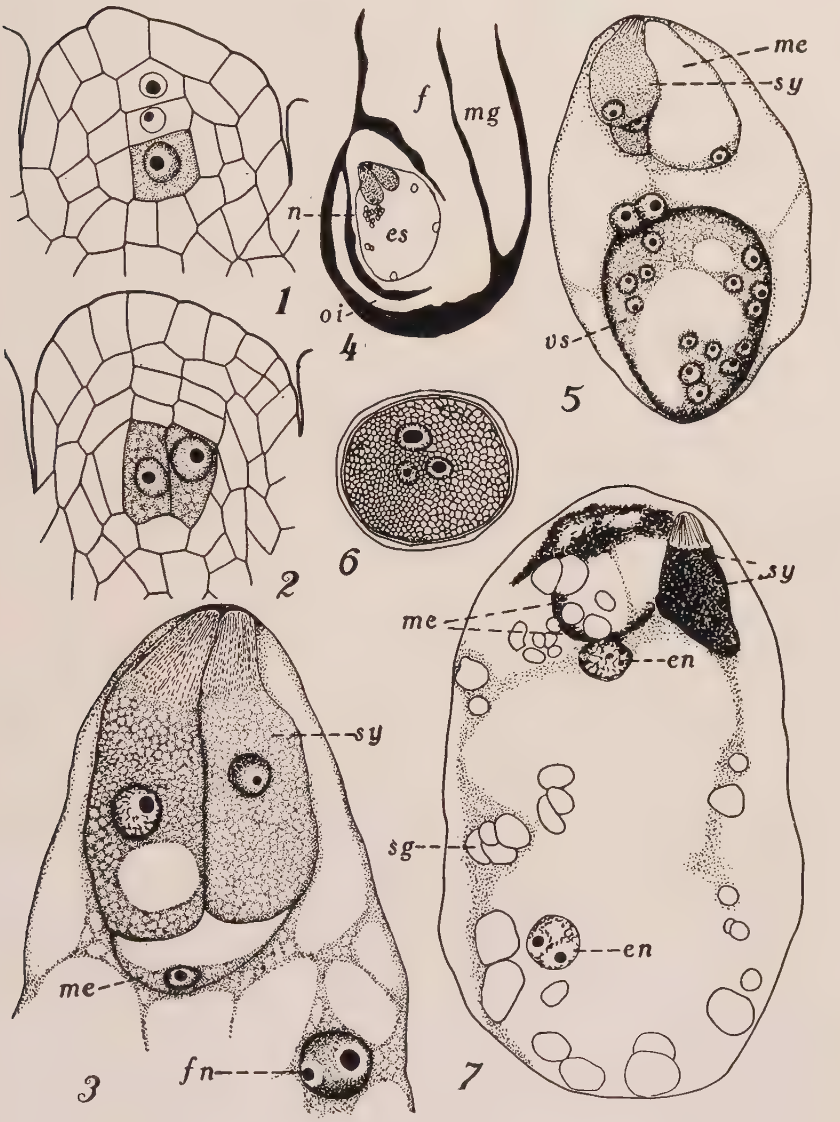
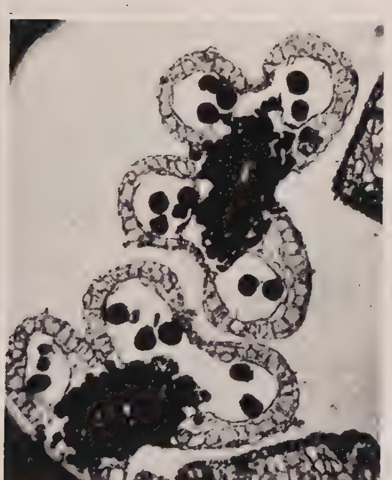


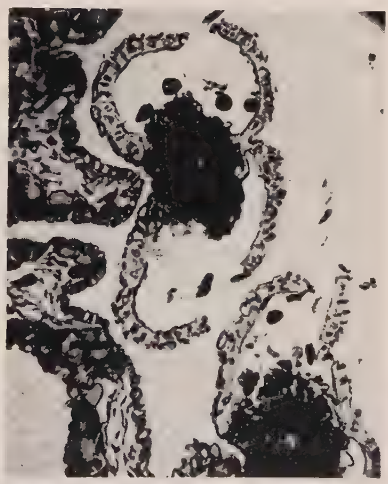
PLATE I

8

9



10



11

PLATE II

COTTON CULTURE [1]

EULALIO P. BALTAZAR
Of the Department of Agronomy

WITH THIRTEEN TEXT FIGURES

That there is increasing interest in cotton growing among the Filipino farmers is shown by the number of inquiries on the subject that are received in this College. To facilitate the answering of these inquiries and to furnish a brief guide in cotton growing, this circular was prepared.

The word "cotton" is applied to the fibrous portion of the fruit of a plant that belongs to several species of the genus *Gossypium*. of the family Malvaceae. The word is also used to designate the plant itself.

Species of cotton. Some of the more important commercial species of cotton included under the genus *Gossypium* are *arboreum* and *peruvianum*, grown only in the tropics; *barbadense*, the source of the Sea Island and the Egyptian, two cottons of very special quality; *herbaceum*, the species from which most of the Indian crops are derived; *hirsutum* (so called because of its hairy stem, branch and leaf) from which most of the upland cotton of the United States is obtained; and *brasiliense*. Most of the Philippine cotton is derived from *Gossypium paniculatum* Blco.

Varieties of cotton. The varieties of commercial cotton are classified or grouped according to: (1) Regions in which it is grown, as the Sea Island cotton which grows best in the Sea Islands and along the coast region of South Carolina, Georgia, and Florida; the Upland, or American cotton cultivated in the southern parts of the United States; the Egyptian grown in Egypt, especially in the Nile Valley; the South American cotton grown chiefly in Peru and in Brazil; and the East Indian cotton cultivated in India. (2) Length of staple, as the "short staple" (25 millimeters) represented by the Chinese, Indian and Upland cottons; "medium staple" (25 to 30 millimeters) of which the cotton grown in the Philippines, Brazil, Russia, West Africa and Peru are examples; "long staple" (30 to 40 millimeters)

---

[1] Experiment Station contribution No. 972. Circular No. 28. Received for publication June 23, 1934.

represented by the Egyptian, Brazilian, and Sudan cottons; and "extra" (40 or over 40 millimeters) from the Sea Island or from some of its hybrids.

The varieties of cotton are so numerous that the characteristics of only the most important ones are here given. Among some of the leading varieties of cotton are the Sea Island and the Egyptian which are noted for their long, fine silky fibers; the Brazilian, famous for its harsh medium-long lint; the Peruvian, well known for its rough, wiry, strong fiber; the Indian, which gives very coarse, short, strong fiber; and the Upland, the most popular and useful of all. The Upland is the variety which furnishes most of the fiber used in the

Fig. 1.—A typical plant of the variety Ilocos White, representing the Philippine group. Note the lodging characteristic of the plant.

manufacture of ordinary cotton textiles. The Indian fiber is used in making denim, canvas and duck and such cotton textiles.

The Philippine Islands has four leading native varieties, three of which have been named each according to the color of its lint. These varieties are the White, the Brown and the Light Brown known in the Ilocos provinces as *Kapas Purao, Kapas Keuti and Kapas Cacao*, respectively. The cotton which grows to the size of a small tree is the fourth variety and is known in the northern provinces as *Kapas wag-wag*. Six foreign varieties of cotton have been introduced into the Islands by the College of Agriculture where they

are under test. These varieties are the Sea Island and the Egyptian cottons, the Cleveland Big Boll, Mebane, the Million Dollar Variety and Acala.

The variety White, usually known as Ilocos White and Batangas White, is the typical cotton of the Philippines. It is grown in Abra, Ilocos Norte, Ilocos Sur, La Union, Pangasinan, Tarlac, Batangas and other provinces in Luzon. The Cebu-Iloilo or Negros White is probably identical with the Ilocos or Batangas White. The plant of the variety White grows from 30 to 200 centimeters high, depending upon the soil type in which it is grown. The flower of the plant has five petals, very light cream yellow upon opening, and turn-

Fig. 2.—A typical plant of the variety Ilocos Brown. Note the lodging characteristic of the plant.

ing reddish pink one day later. The boll of this variety is made up of from three to five locks. The seed is covered with light greenish white fuzz.

The variety Brown in all respects, except in color of the lint, resembles the variety White. The lint is dark brown. The variety Light Brown closely resembles the variety Brown except that its lint is of lighter brown color. According to the findings of the College of Agriculture, the Light Brown variety is perhaps a hybrid between the varieties White and Brown, for when seeds of the variety Brown were planted, Brown, Light Brown and White offspring were

obtained. The small tree cotton is a perennial variety, ranging from two to six meters in height. The lint is medium fine and rather silky, but short, two and a half centimeters in length.

Some of these varieties are shown in figures 1–7. Figure 8 shows the typical form and average size of the bolls of the different varieties of cotton grown in the College fields. The classification or

Fig. 3 —A typical plant of the variety Batangas White, representing the Philippine group. Note the upright growth of the plant.

grouping of cotton varieties according to the length of staple is shown in figure 9.

Soil requirements. Provided the drainage is good, cotton has been reported to thrive, though with varying success, on almost all types of soil, from light sandy loam to heavy clay loam. On extremely

light, sandy soils the plant has been found not to grow very well. When provided with sufficient moisture, it grows to a fair height on heavy types of soil, but the fiber produced is inferior and limited in amount. The best soil type for cotton growing is sandy loam.

Climatic requirements. When young, the crop flourishes best in warm, moist weather. Occasional showers, or light rainfall during

Fig. 4.—A plant of the variety Acala, representing the Mexican-Central American group. It is an upland cotton commonly grown in the southern parts of the United States.

the pre-blooming period is very beneficial for the vegetative development of the plant, but too much rain or too much water in the soil tends to increase weeding expense and may cause the plants to produce too much of the woody parts, possibly at the expense of fiber

Fig. 5.—A plant of the variety Cleveland Big Boll, representing the common upland cotton of the United States. Note the character of the growth of the plant.

production. On the other hand, severe drought stunts the plant, matures it too early and consequently gives a low yield as the staple produced is small and light. From the time the plant is about to bloom, warm, dry weather is best for the production of a superior, heavy-staple crop and for convenient harvesting.

Varietal selection. The selection of the variety to plant depends mainly upon the type of cotton that is desired. If a cheap cotton of medium or short staple is desired, the best Philippine or American upland varieties should be tried. Of the six foreign varieties introduced into and tested in this College, Acala and Cleveland Big Boll have been found to be heavy yielders of lint and to thrive very well under Los Baños conditions, and therefore should merit the first consideration of the Filipino farmers before other varieties of questionable and unknown qualities should be tried. According to the findings of this College, the Ilocos White is a heavier yielder of lint than the Batangas White, but the Ilocos White variety has the tendency to lodge on the ground. Where the soil is sandy and rather dry during time of harvest, the Ilocos White should be preferred; where conditions are otherwise, the Batangas White should be selected.

If fineness, strength, silkiness and evenness of staple are desired, the Sea Island and the Egyptian cottons should be tried. These two varieties are usually used for the manufacture of hosiery, laces, neckties, fine muslins, silk imitations, and other expensive textile articles. The Peruvian cotton has long been known for its rough, strong woolly fiber. This cotton is used for the manufacture of underwear and hosiery and is especially used for mixing with or as a substitute for wool.

Seed selection. The desirable characters upon which selection of bolls for seed should be based are trueness to type, soundness, uniformity of size, persistence of attachment or non-shedding quality, and high yield of lint and resistance of the mother plant to pests and diseases.

As the crop nears maturity, the planter should begin to observe his cotton plants more closely preparatory to selecting his seed, for the plants vary. The planter should select as sources of seeds such mother plants as are desirable. After the plants reach maturity, he should go through his field, select and mark the stout, short-jointed vigorous and very high yielding plants that are growing far from the edges of the field. Only the choicest bolls around the center of the selected plants should be selected. The fruit bearing branches of the selected plants should be well fruited up to the end and should

Fig. 6.—A plant of the variety Pima Egyptian, representing the South American group. Note the large number of branches of the plant.

be short-jointed here and there. This is the best type of plant for seed and the planter should go through his whole field and select individual plants that possess these characteristics. In picking the bolls from which seeds are to be obtained, the cotton planter should

Fig. 7.—A plant of the variety Sea Island, representing the group of cottons grown on the islands off the coast of South Carolina. It is supposed to have originated in South America.

reject those at the end of the limbs or those that appear close to the ground, for the top, end, and low bolls do not mature well.

Preparation of the land. In Abra, Ilocos Norte, Ilocos Sur, La Union, Pangasinan, and Tarlac, the land is prepared for cotton plant-

ing just after the rice harvest. This period falls during the latter part of November and early part of December. In Laguna, Tayabas, Batangas and other neighboring provinces, land preparation is begun as early as September.

The land from which rice or any other crop has just been harvested should be prepared as thoroughly but as cheaply as possible. The soil right after the rice is harvested is in good condition for plowing, as it is neither too wet nor too dry. It can be put in fine tilth by plowing and harrowing it two times. As soon as the land is made level and the surface soil is made smooth, the cotton may be sown.

Sowing the seed. There are three culture methods used with cotton. They are known as the "flat culture", "ridge culture", and the "list culture". Where drainage is good, the soil friable and porous, and where artificial or natural fertilizers are drilled in, flat culture is the best. Where the soil is rather wet and where drainage is poor, ridge culture is preferable. Where the soil is rather dry, list culture will give the best results.

In the ordinary flat culture method, the field is furrowed and the seed is sown right in the furrows which should be from 75 to 100 centimeters apart. In the ridge culture method, the field is ridged and the seed is sown on the middle of the ridges. In the list culture method, the field is plowed deep and the soil thrown into ridges with the lists between them. The seed is sown in these lists.

If the seed is fresh, about a year old or less, and the percentage of germination is high, as many as three seeds should be dropped in a hole, but if the percentage of germination is low, as is the case with seed about two years old, five should be dropped. The seeds should be buried about five centimeters deep in the soil. If the surface soil is rather dry, the seeds should be buried a little deeper, say eight centimeters. In the United States seed drills are used in planting cotton.

Distance of planting. The distance at which cotton should be planted varies according to soil type. Under Los Baños conditions, in ordinary clay loam soil the best distancing was found to be 50 × 75 centimeters. This spacing gave the best yield of capsules, lint, and seeds. In sandy loam soil of medium fertility, from 70 to 90 centimeters between furrows and hills in the furrows would be satisfactory distancing; in very fertile soil, from 80 to 100 centimeters would be better. With these distances of planting it would take from three to six gantas of seeds to plant one hectare of land, as there are

about 6500 seeds in a ganta. The College of Agriculture is experimenting on closer distancing than 50 × 75 centimeters.

Application of fertilizers. The Filipino farmers do not usually fertilize their cotton crop. The only form of fertilizer or fertilizers added to the soil is the little wood ashes thrown into the field from a nearby house, or dung dropped by animals grazing in the field. It has been reported by experiment stations in the United States that fertilizers have materially increased the yield of cotton. Rotation of crops and green manuring also have been found to increase the production.

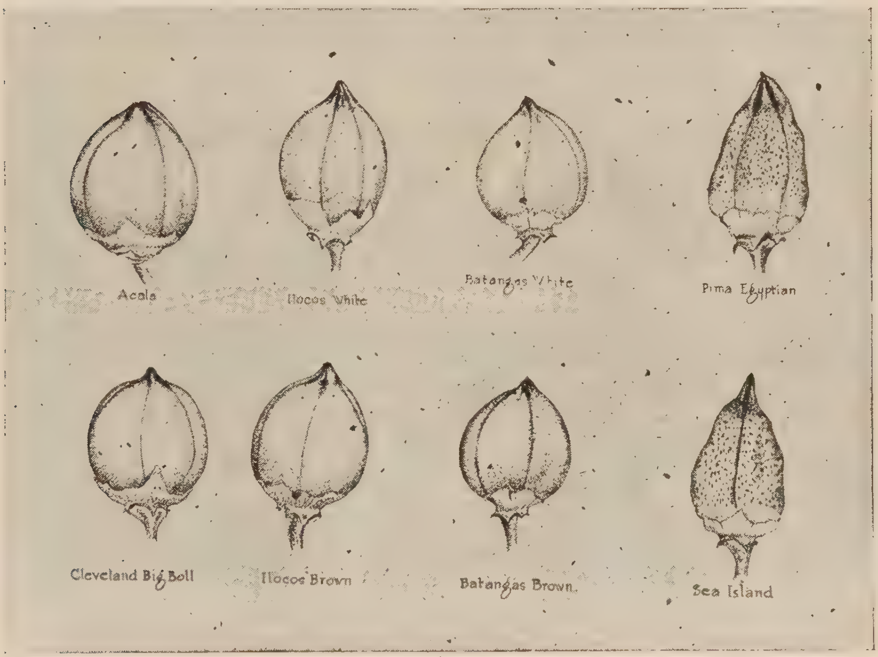


Fig. 8.—Showing the typical form and the relative size of the bolls of the different varieties of cotton grown in the College fields. Note the almost spherical form of the Acala and Cleveland Big Boll, the oval or oblong shape of the Philippine varieties, and the tapering pointed outline of the Pima Egyptian and the Sea Island cottons.

Various forms of fertilizer have been used in the United States and in other countries in cotton production. In the "Auburn method" of fertilization, there is applied at planting time 61.63 kilograms of sodium nitrate, 448.17 kilograms of superphosphate, and 61.63 kilograms of muriate of potash approximating the formula 2–12–5. A month later, 168.06 kilograms of sodium nitrate or some other nitrogenous fertilizers are applied as a side dressing.

The College of Agriculture is conducting at present a series of complete fertilizer experiments on cotton, involving different rates of application, using the formulae 3–9–3 (1–3–1), 5–10–5 (1–2–1), 1–4–1, 1–3–2, 2–4–1, 2–1–4, etc. The object of these experiments is to determine the effect of a given formula mixture at different rates of application on the growth and yield of the cotton plant. Among some of the results recently obtained from the use of the 3–9–3 fertilizer mixture applied at the rates of 300, 400, 500 and 600 kilograms per hectare are the following:

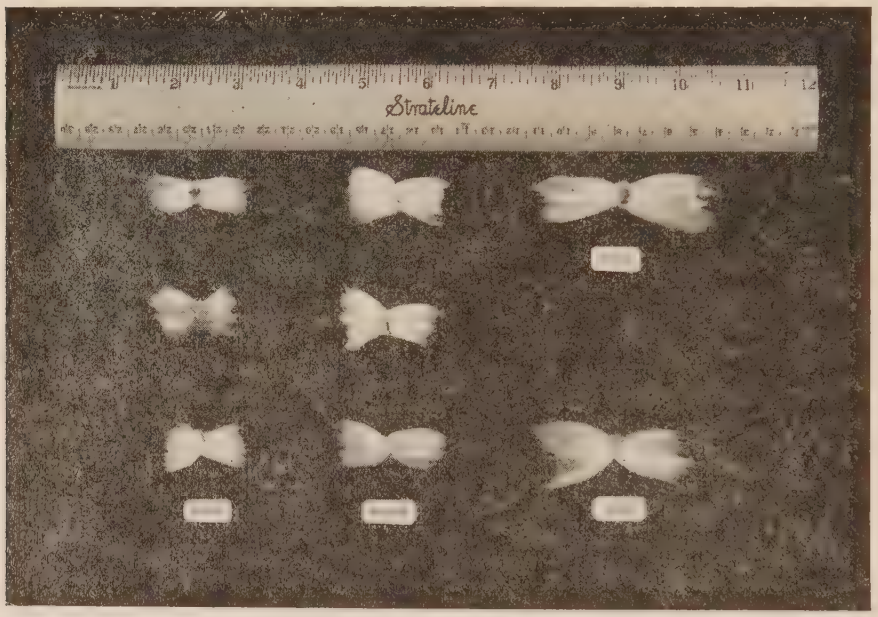


Fig. 9.—Lint combed out on seeds to show range of length of staple of different varieties of cotton grown in the College fields. Reading from bottom to top. (*Short*) Cleveland Big Boll, Ilocos Brown and *Kapas wag-wag;* (*Medium*) Ilocos Light Brown, Ilocos White and Acala; (*Long*) Pima Egyptian; (*Extra*) Sea Island.

All fertilized plants were taller than the unfertilized ones; the plants treated with 400 kilograms per hectare were the tallest. The average diameter of the crown of the control plants was shorter than that of the plants which received different rates of fertilizer application. The plants which received 400 kilograms per hectare produced the largest number of bolls and also the greatest weight of capsules, seeds and lint; the unfertilized plants had the lowest yield. The mean yield of lint per hectare of those plants which received the 400

kilograms treatment was 216 kilograms and that of the control plants was 72 kilograms.

Thinning. In from three to six days, the seeds begin to germinate. One week after the seeds have germinated, the seedlings will be from 7 to 15 centimeters above the ground, and the first true leaf appears. This is the best time for pulling up the undesirable seedlings, such as those that show signs of being attacked by thrips and those that are tall, slender and spindly. The more vigorous ones should be left. Whether one or two seedlings are left in each hill is still under investigation. Greater yields have been reported with from two to three seedlings to a hill than with one, but the quality of crop was inferior. As stated elsewhere in this paper, one plant to a hill distanced 50 × 75 centimeters has been found so far to be the best under Los Baños conditions.

Cultivation. In any form of crop growing, thorough and effective cultivation is very essential, if a good yield is to be obtained. With cotton, two or three weeks after the seeds have germinated, light, shallow cultivation with light tools should begin. This kind of cultivation should consist only in freeing the field from weeds and in putting the surface soil around the plants in fine tilth. It should be maintained until the plants have reached their maximum lateral spread, which is usually attained when they are a little over three months old.

Diseases. Among some of the common diseases of cotton in the Philippines are the mosaic, the seedling rot, or damping-off, the anthracnose of cotton, the "wilt disease," the angular leaf spot and the root gall of cotton. The mosaic is characterized by the yellow blight on the leaves and the shedding of the bolls. A heavy application of kainit has been found to cure the malady. The damping-off of cotton is caused by *Pythium debaryanum*. The young plants are usually attacked by the fungus at their base and later they rot off. Proper soil aëration would partly check the injury caused by damping-off. The anthracnose of cotton is due to *Glomerella gossypii*. The fungus attacks the bolls, stems and leaves. Standard Bordeaux mixture spray and seed fumigation or sterilization would help to minimize the injury caused by this disease. The "wilt disease" is probably caused by a species of *Fusarium*. The attacked plants are usually dwarfed and have a very unhealthy appearance. The leaves turn yellow between the veins and the plants die or partly recover, depending upon their vigor and resistance. Resistant varieties if

available, provided they are desirable also in other respects, should be planted in order to minimize the loss caused by this disease. The angular leaf spot of cotton is caused by *Bacterium malvacearum*. The organism attacks the leaves and bolls of the plant. Bordeaux mixture spray should be used to reduce the injury caused by this disease. The root gall is caused by *Heterodera radicicola*. The minute

Fig. 10.—A native cotton gin in operation. (*a*) Unginned cotton; (*b*) ginned cotton. The seeds drop into the box behind the gin.

worms enter the roots, causing galls in them. Crop rotation, aëro-cyanamid spray and burning the soil and the attacked plants will help to reduce the injury caused by root galls.

Pests. The most common insect pest of cotton in the Philippines is the oriental cotton stainer, *Dysdercus megalopygus* Bredd. It is called *bacabaca* by the Ilocanos and *bacabacahan* by the Tagalogs.

This is an insect whose head, the underside of the abdomen and the front part of the thorax are red. The insect punctures the immature bolls and the seeds within by thrusting out its proboscis. The punctured seeds exude a kind of material which indelibly stains the lint yellow. The red nymphs which appear in a colony may be brushed off into a can with kerosene in it. Another insect which resembles the cotton stainer is *Dysdercus poecilus* H. S. This insect punctures the bolls and seeds of the cotton plant, and stains the lint yellow.

Tectocoris lineola Fabr. is a large red insect common in the cotton fields of northern Luzon. The insect, which is over one centimeter long and about one centimeter wide, sucks the sap of the young shoot of the cotton plant. The injury caused by this pest is of minor importance. The cotton bollworm, *Heliothis obsoleta* Fabr. is a serious pest in the Ilocano provinces. The larva feeds on the squares, flowers and bolls of the cotton plant. The damage is sometimes considerable when the larvae become abundant in the field.

Some of the common insect pests observed at the College of Agriculture are here briefly described. (1) *Phaneroptera furcifera* Stål. is an insect that feeds on the young leaves. It belongs to the order *Orthoptera*, family Tettigoniidae. (2) *Helopeltis* spp. is an insect that sucks the sap of the young shoot of the cotton and punctures made by the proboscis causes a blight-like effect on it. The damage is rather serious in the College fields. This insect belongs to the order Hemiptera, family Capsidae. (3) *Ricania speculum* Fabr. is a minor pest of cotton. The insect sucks the sap of the shoot and the young leaves of the plant. It is a homopterous insect of the family Ricaniidae. (4) *Drosicha townsendi* Ckll. sucks the juice of the stem and leaves of the plant. It is a minor pest of cotton. It is a homopterous insect of the family Coccidae. (5) *Amorphoidea lata* Motsch. is called the Philippine boll weevil. The adult insect does considerable damage on the cotton plants in the College fields. It is a coleopterous insect of the family Curculionidae. (6) *Cosmophila erosa* Hübn. is a noctuid the larva of which feeds on the leaves. It is of minor importance. The larvae should be picked off or brushed into a can in which there is a little kerosene. (7) *Sylepta derogata* Fabr. is an insect whose caterpillar feeds on the leaf. The insect may become a serious pest. It is a pyralid. (8) *Euproctis varians* Wlk. is an insect that feeds on the leaves of the cotton plant. It belongs to the family Liparidae of the order Lepidoptera.

Other cotton pests of minor importance observed in the College of Agriculture are *Antilochus nigripes* Burm., *Nezara viridula* Linn., and *Acontia intersepta* Guén.

The general methods of controlling these insects are by hand-picking if labor is cheap or readily available, the use of insecticides, such as lead arsenate, calcium arsenate and Paris green when found economical, and the adoption of clean culture and frequent cultivation.

Harvesting. In four to five months from the date of planting the seed, harvesting may be begun. This period usually falls in the months from February to May. As soon as the bolls mature they are picked one by one by hand, deposited in large baskets and then placed on mats in the sunshine to dry. This is the Filipino practice. A better way to harvest the crop is practiced in the United States; there the lint is picked directly from the open bolls. In this way

Fig. 11.—Showing the process of loosening the cotton fiber and making it soft and uniform in texture by beating it with two bamboo sticks on a large flat basket.

of harvesting, the lint is at once separated from the bracts and capsules of the bolls and the mixing of lint and broken bracts and other dirt is avoided. Care should be taken that the bolls are gathered as soon as they open, for if neglected, the lint is blown off by the wind, or drops to the ground and becomes dirty. As all of the bolls do not mature at one time, it is necessary that picking be done a number of times. From 15 to 20 per cent of the whole crop is harvested at the first picking, 55 to 60 per cent at the second, 15 per cent at the third, and the remainder during the fourth, fifth, and probably the sixth pickings.

Yield. The average yield of cotton per hectare in the Philippines can not be accurately determined as the farmers have no definite standard system of distancing their plants. One reason the yield is so variable is that the mode of cultivation as influenced by soil and climatic conditions is not uniform throughout the Islands.

Approximately, the average number of bolls produced by a cotton plant of the variety White, as observed in College plantings, is from 10 to 12 when the crop is grown on heavy poor soil; 12 to 15 on ordinary clay loams; and 15 to 20 on sandy loam of medium fertility. The size of the bolls depends upon soil type, distance of planting and number of plants to a hill. The average weight of one boll is 5.6

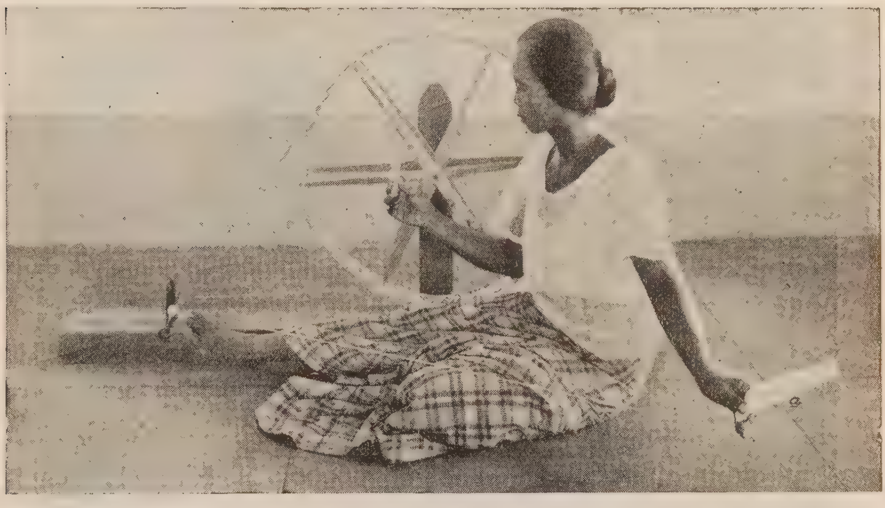


Fig. 12.—Spinning the cotton fiber into yarn. (*a*) Distaff; (*b*) peg by which spinner turns the wheel; (*c*) bobbin with the spun yarn.

grams. Each boll is made up of approximately 20 per cent of lint, 35 per cent of bracts and capsules and 45 per cent of seeds.

The figures given below are approximate computed yields of cotton per hectare when grown in different types of soil at different places.

Heavy soils,	550–650 kilograms of cotton bolls.
Clay loam,	650–750 kilograms of cotton bolls.
Sandy loam,	750–900 kilograms of cotton bolls.

The approximate average yield of bolls per hectare is around 650 to 750 kilograms. These bolls give a yield of 390 to 450 kilograms of seed cotton equivalent to from 130 to 150 kilograms of clean lint.

Ginning. As soon as the bolls are thoroughly dry, the lint is separated from the bracts and capsules carefully, for if carelessly done, the dry and brittle bracts are broken and get mixed with the lint. The dry, fluffy lint is then ginned so as to free it from the seed it

Fig. 13.—Skeining the yarn on a bamboo reel.

contains. In order to facilitate ginning, it is necessary to dry the lint in the sun for at least half a day. If possible, ginning should be done on hot dry days and never on rainy, humid days. Using the native

gin, it takes about five hours to gin one kilogram of lint of the variety White, five and a half hours for Brown, three and a half hours for *Kapas wag-wag*, four hours for Pima Egyptian, and three and a half hours for the Sea Island. To lower the cost of production of cotton lint, a modern method of ginning will have to be utilized in the Philippines. After the cotton is ginned, about 65 per cent in weight remains as seed and 35 per cent as fiber. (See fig. 10.)

Grading. The Filipino farmers do not grade their cotton, as the production is very limited and the crop is used in the locality where grown. But in order to know what grade of cotton is sold in the market, they should learn how to grade their cotton according to length of the staple, fineness, color and luster, freedom from dead or unripe fiber, dirt and other foreign materials, and also the amount of moisture in the staple. About four per cent moisture is allowed in the fiber. There are nine standard grades of cotton in all cotton markets based on middling cotton. They are middling fair, strict middling, good middling, strict good middling, middling, strict low middling, low middling, strict good ordinary, and good ordinary. Grades of cotton above middling are higher in quality and those below, poorer.

Baling. The Filipino farmers do not bale their cotton, as it is woven in the locality where it is produced. They should learn how to pack their product neatly so when they have a surplus they will be able to ship it to Manila in a marketable condition.

The American cotton is packed in bales of 500 pounds. The East Indian cotton is shipped in cubical bales which weigh approximately 400 pounds; the Egyptian, in bales of 700 pounds; and the Brazilian, in bales of 200 pounds. It takes about 1500 pounds of seed cotton to produce 1 bale of 500 pounds; 1200 pounds for 400; 2100 pounds for 700; and 600 pounds for 200. These bales of cotton from various countries are shipped to Japan, France, England, Germany, Italy, and Russia to be manufactured into various forms of textile goods and other articles.

Spinning. The Filipino cotton farmers usually weave their locally raised product, but sometimes they sell it in the form of seed cotton, clean cotton and yarn. The steps involved in making the yarn are shown in figures 10–13. These native methods are slow, tedious and antiquated. To lower the cost of production, modern methods of ginning and spinning should be used.

COMPARISON OF YIELDS FROM RAMAI VARIETY OF RICE BROADCAST AND TRANSPLANTED [1]

JUSTO P. CAPILI

INTRODUCTION

Lowland rice (*Oryza sativa* Linn.) is grown in the Philippines by either transplanting or broadcasting the seed in the fields. The transplanting method involves greater expense than the broadcast method as it requires much time and skilled labor. Camus (1921) stated that the principal disadvantages with the broadcast method are the necessity of special care in leveling the paddies, the impossibility of sowing evenly by hand, the consequent waste of seed and the impracticability of weeding. It is the general opinion among the rice growers that the transplanting method gives a better and a larger yield than the broadcast. If, however, the broadcast method would yield about the same amount as the transplanting, it would be to the advantage of both the producer and the consumer as the cost of production per unit area is less than by the transplanting method.

In Konkan, India, Joshi (1924) conducted an experiment for five years, which showed considerable promise in the growing of rice without transplanting. With direct planting, he obtained a yield of 2,820 pounds, or 1,281.82 kilograms per acre as compared with 2,610 pounds or 1,186.36 kilograms per acre using the transplanting method. The seed, however, in the direct planting was drilled in straight lines providing spaces for weeding.

As no study had been made in the Philippines on the comparison of yield from these two methods of planting rice the work herein reported was undertaken. The specific object was to find the difference in the yield of Ramai rice when it was broadcast and when it was transplanted. The work was conducted on the Experiment Station grounds from August, 1930 to January, 1931.

SEED BED

The *dapog* method of planting rice seed in seed bed was used. The seed bed was rectangular with an area of 4.22 square meters.

---

[1] Thesis presented for graduation, 1931, with the degree of Bachelor of Science in Agriculture, from the College of Agriculture No. 391; Experiment Station contribution No. 973. Prepared in the Department of Agronomy under the direction of Mr. Vicente B. Aragon and Mr. Alejandro B. Catambay.

It was located near an irrigation ditch where water was available any time of the day. The seed bed was plowed once, on August 17, 1930, and harrowed the next day, puddled thoroughly and finally leveled. Unlike the seed bed made by the *punlaan*[2] method the seed bed by the *dapog* method can be made on any kind of soil, provided there is sufficient moisture available. It is made by laying a mat of banana leaves on the surface of the seed bed with the split midrib of the leaves forming an outside border. A thin layer of chopped rice straw is spread evenly over the surface of the banana leaves. According to Camus (1921) if there is no available rice straw the banana leaves may be pressed three centimeters deep into the mud. The layer of mud on the surface serves the same purpose as the rice straw would, which is to be a temporary anchorage for the growing rice seedling. The mat of the banana leaves is to prevent the rice roots from penetrating the soil, so that the seedlings may be easily removed for transplanting.

FIELDS

The lots were located in the lowland rice fields of the College. Ten paddies, each 324 square meters in area were used in the work. Five paddies, Ncs. 1, 3, 5, 7 and 9 were planted by broadcasting the seeds, and the remaining five, Nos. 2, 4, 6, 8 and 10 were transplanted. Only one planting was made. The arrangement of the paddies is shown in the diagram.

2	3	6	7	10
1	4	5	8	9

Diagram. Showing arrangement of fields. Paddies 1, 3, 5, 7, and 9 were sown broadcast. Paddies 2, 4, 6, 8, and 10 were planted with transplanted seedlings.

VARIETY OF RICE USED

The variety of rice used was the Ramai. The seeds were secured from the Farm Crops Division of the Department of Agronomy. They were mass selected from the crop of 1929-30.

[2] In this method, sprouted seeds are sown in a well prepared paddy. The seedlings are allowed to grow from 30 to 40 days in the seed bed. They are then pulled up and transplanted into permanent fields.

This variety was recently introduced into the College of Agriculture from the Central Luzon Agricultural School at Muñoz. It proved to be the heaviest yielder of all the lowland varieties tried at that school. In a production test of this variety (transplanted), Aragon (1930) obtained 276 kilograms of palay from one-half kilogram of seed planted.

CULTURAL METHODS

Transplanted rice

Preparation of land. The fields were plowed on August 8, 1930, turning under all the weeds, which were abundant. After plowing, sufficient water to cover the clods was let into the fields. Two days later the paddies were harrowed lengthwise to break the clods. After the first harrowing, water was let into the field to the full capacity of the dikes and left for five days so that the straw and weeds and grass which were plowed under would decay. When the water was drained off the second harrowing followed. The paddies were again flooded for three days so that the weeds and straw would further decay. On the fourth day the water was again drained off and the soil was puddled and leveled ready for transplanting. The puddled soil was about 12 centimeters deep so that the seedlings could be easily planted.

Sowing rice on seed bed. Five gantas of seed in a sack were soaked in running water for 12 hours, the length of time that Mr. Aragon had found best with this variety in Muñoz. After soaking, the sack of seeds was placed in the shade for 36 hours for the seeds to germinate. The seeds were broadcast evenly and thinly on the prepared seed bed on August 19, 1930. The planted seed bed was sprinkled with water, morning, noon, and afternoon for four consecutive days. On the fifth day, water was allowed to flow continuously on the seed bed, as the seedlings were no longer in danger of being washed away. The object in letting the water flow continuously was to keep it cool, otherwise it would injure the growing seedlings. When nine days old the seedlings were pulled up and transplanted. The usual practice of the farmers in Calamba, Los Baños, and Bay, Laguna, is to transplant the dapog-grown seedlings to the fields when they are from eight to ten days old. If the seedlings are allowed to stay longer than ten days in the seed bed the roots will penetrate the mat of banana leaves and the seedlings will be hard to pull up.

Transplanting. The mat of seedlings was carefully divided into five equal parts. Each part was planted in a separate paddy. Three skilled women transplanters were hired to do the transplanting on

August 28, 1930. A planter carried seedlings in one hand and with the other planted 3 or 4 seedlings in the mud at a time. The hills were distanced about 20 centimeters each way. Mr. Aragon had found this distance to be the best with this variety in Muñoz and in his plots in the College of Agriculture Experiment Station. The planters were very careful not to waste any of the seedlings. Seedlings from one ganta of seed palay were planted to a paddy of 324 square meters.

Irrigation. There is an irrigation system in the College of Agriculture, but the supply of water depends upon rain. Because of a shortage of water during the hot dry days in October the plants suffered from drought.

Weeding. There were so few weeds that the transplanted fields were not weeded. The rice plants had an early luxuriant growth which shadowed the surface of the paddies. This and the presence of abundant water during the early part of the plant growth helped the plants prevent the growth of weeds.

Harvesting, threshing and winnowing. Hand labor was employed in harvesting, threshing and winnowing. The rice was harvested on January 28, 1931. In harvesting, the plants in each plot were cut about 45 centimeters from the ground with a *pangapas* (a native implement) and piled in a convenient place in the plot. Threshing was done by treading. The threshed palay was then winnowed and the yield from each paddy weighed separately.

Broadcast rice

Preparation of the fields. The preparation of the fields for planting rice by broadcasting was the same as that for the transplanted fields, except in the final harrowing. For broadcasting, the water in the paddies was drained off leaving a soil with a very sticky surface which prevented the sinking of the germinated seeds deep into the mud, when sown broadcast.

Broadcasting. The rice seed was divided equally into five parts, one part, equivalent to one ganta, was planted to a paddy. A hired planter standing on any convenient place on the dike took a handful of germinated seeds and broadcast them over the field. This was done on August 19, 1930, the same date the seeds were sown in the seed bed for the transplanting method. The one who broadcast was careful to sow the seeds as uniformly as possible.

A girl was hired to keep the birds away from the broadcast seeds.

Irrigation. Water was not turned into the fields until August 29, 1930, 10 days after the seeds were broadcast. By that time the young rice plants were firmly established in the ground and there

was no danger of their being washed away. As the supply of water depended upon the rain the plants suffered from drought during the hot days in October.

Weeding. There were many weeds in the broadcast fields. But no weeding was done as it was desired to give the plants the same treatment as that given the transplanted plants.

Harvesting, threshing and winnowing. Harvesting, threshing and winnowing were done in the same way as with the transplanted rice. The broadcast rice plants were harvested on January 22, 1931, six days earlier than the transplanted ones, and were threshed and winnowed on the same date.

RESULTS

Tables 1 and 2 give the maturity of the Ramai variety in number of days. It took 156 days for the broadcast rice to mature (see table 1) and 162 days for the transplanted rice (see table 2).

Table 3 shows the actual cost of production for 1,620 square meters of ground for each method and the computed cost of production per hectare for each. For the broadcast method the cost of production for the 1,620 square meters was ₱15.77 and the computed cost per hectare was ₱97.63. For the 1,620 square meters of transplanted rice the cost of production was ₱21.11 and the computed cost per hectare was ₱130.33.

Table 4 shows the actual yield of each of the five paddies in kilograms and in cavans for the broadcast method. The actual average yield for one lot was 66.54 ± 3.77 kilograms or 1.51 ± 0.01 cavans. The computed yield per hectare was 2,053.70 ± 116.32 kilograms or 46.68 ± 0.26 cavans.

Table 5 gives the actual yield of each of the five paddies in kilograms and in cavans for the transplanted rice. The actual average yield for one lot was 95.10 ± 4.74 kilograms or 2.16 ± 0.11 cavans. The computed yield per hectare was 2,935.18 ±149.48 or 66.71 ± 3.32 cavans.

DISCUSSION OF RESULTS

Periods of blooming and maturity

Tables 1 and 2 show the number of days required to mature Ramai rice planted with the transplanting and the broadcast methods. The time required by the broadcast rice plants to mature was shorter than that for the transplanted rice. The broadcast rice plants were sown on August 19, 1930, bloomed December 16, 1930 and were matured by January 22, 1931. The transplanted rice was broadcast

on the seed bed August 19, 1930, transplanted August 28, 1930, bloomed December 25, 1930 and was matured by January 28, 1931. It took 156 days for the broadcast rice to mature and 162 days for the transplanted. The pulling up of the seedlings from the seed bed and transplanting them to the field disturbed the growth thus causing the delay of six days in maturing. In the broadcast method the growth was not retarded and the development of the plant was not disturbed.

Aragon (1930) stated that transplanted rice seedlings began to grow again within two weeks after transplanting. With the transplanting method, then, the growth was retarded and the period required to mature was prolonged.

Cost of production

Table 3 shows the total cost of working 1,620 square meters of ground for each method. The cost of production for the transplanting method was more than for that of the broadcast. The cost was ₱130.33 per hectare for the transplanted and ₱97.63 for the boradcast, giving a difference of ₱32.70 per hectare in favor of the broadcast. The cost of transplanting accounts for the difference. The expenses for the other items were the same in the two methods. Land rent was ₱20.00 per hectare in the lowland fields around Los Baños. This was taken as the assumed rent for College land. The seed palay cost ₱5.00 a cavan and each plowing and harrowing cost ₱2.00 a day. The expenses in harvesting, threshing and winnowing were based on the usual practice of giving one-fifth of the crop to the harvester. *Maya* or sparrows (*Passer mantanus* Linn.) are so numerous in the vicinity of the College that it was necessary to hire a girl at a cost of ₱0.50 a day to drive them away.

Yield per hectare

Table 4 gives the actual production and the computed yield per hectare of the broadcast rice plants. In these paddies the weeds were abundant which naturally affected the growth of the plants. The computed yield per hectare was 2,053.70 ± 116.32 kilograms or 46.68 ± 0.26 cavans. In the transplanted paddies the computed yield per hectare was 2,935.18 ± 149.48 kilograms or 66.71 ± 3.32 cavans (see table 5).

There was a significant difference of 20.03 ± 3.33 cavans in favor of the transplanting method. The low production obtained with the broadcast method may be attributed to the abundance of weeds and the over-crowding of the plants in some places in the paddies.

Cabailo (1925) found in his study on weeds in the lowland rice fields and their effect on the yield of grain, that the yield of rice is affected by weeds. Fields which were weeded gave higher yields than those fields which were not weeded.

Cost of producing per cavan

Table 6 shows the cost of producing a cavan of palay by each of the two methods. The cost of producing a cavan by the transplanting method was ₱1.95, and the broadcast ₱2.09; giving a difference of ₱0.14 in favor of the transplanting method. This difference in the cost was caused by the higher yield per hectare with the transplanting method.

SUMMARY

1. The broadcast Ramai rice plants matured six days earlier than the transplanted rice plants. The plants from the broadcast matured within 156 days after sowing; the transplanted plants, using the *dapog* method of making seed bed, matured within 162 days after sowing in seed bed.

2. There was over-crowding of the rice plants in some parts of the broadcast paddies because of the lack of uniformity in sowing. In these parts, as a consequence, the plants were stunted.

3. The cost of production by the transplanting method was ₱130.33 per hectare and by the broadcast, ₱97.63. Production by the transplanting method cost ₱32.70 more than by the broadcast method.

4. The yield was 20.03 ± 3.33 cavans greater per hectare by the transplanting method than by the broadcast, the yield per hectare in the former being 66.71 ± 3.32 cavans and in the latter, 46.68 ± 0.26 cavans.

5. The cost of producing one cavan of rough rice by the transplanting method was ₱0.14 less than by the broadcast method. The cost of producing one cavan of rough rice by the transplanting method was ₱1.95, by the broadcast method, ₱2.09.

LITERATURE CITED

ARAGON, VICENTE B. 1930. Ramai rice and its culture in the Central Luzon Agricultural School. The Philippine Agriculturist **18**: 535–542. *Fig. 1–2.*

CABAILO, BENJAMIN C. 1925. Weeds in the rice fields and their effect on the yields of grain. The Philippine Agriculturist **14**: 359–371. *Fig. 1–3.*

CAMUS, JOSE S. 1921. Rice in the Philippines. Philippine Agricultural Review **14**: 7–86.

JOSHI, P. G. 1924. Rice growing in the Konkan without transplanting. The Agricultural Journal of India **19**: 160–163. *Fig. 1–2.*

TABLE 1

Showing stages in the vegetative growth of the broadcast rice

STAGES	NUMBER OF DAYS
Length of time from broadcasting to blooming	119
Blooming to maturity	37
Broadcasting to maturity	156

TABLE 2

Showing stages in the vegetative growth of the transplanted rice

STAGES	NUMBER OF DAYS
Length of time in seed bed (*dapog method*)	9
Transplanting to blooming	119
Blooming to maturity	34
From sowing the seed in the seed bed to maturity ..	162

TABLE 3

Cost of production per hectare

ITEMS	BROADCAST		TRANSPLANTED	
	Cost		Cost	
	1,620 sq. m.	Per Ha.	1,620 sq. m.	Per Ha.
	pesos	*pesos*	*pesos*	*pesos*
Seed palay	0.55	3.40	0.55	3.40
Rental of land	3.24	20.00	3.24	20.00
Plowing	2.00	12.35	2.00	12.35
Harrowing	4.00	24.69	4.00	24.69
Seed and seed bed preparation	—	—	1.50	9.26
Seed preparation and broadcasting on fields ..	.50	3.09	—	—
Pulling up and transplanting seedlings	—	—	3.00	18.52
Driving away birds (seed bed and main fields)	2.50	15.43	2.50	15.43
Harvesting, threshing and winnowing [a]	3.02	18.67	4.32	26.68
Total	15.77	97.63	21.11	130.33

[a] Based on the usual practice of giving one-fifth of the crop harvested for harvesting, threshing and winnowing.

TABLE 4

Yield per hectare of the broadcast rice

LOT NO.	AREA PLANTED	ACTUAL YIELD		YIELD PER HECTARE	
	sq. m.	*kgm.*	*cavans* [a]	*kgm.*	*cavans*
1	324	45.8	1.04	1,413.58	32.13
3	324	78.3	1.78	2,416.67	54.92
5	324	69.4	1.58	2,141.98	48.68
7	324	65.8	1.50	2,030.86	46.16
9	324	73.4	1.67	2,265.43	51.49
Total ...	1,620	332.7	7.56	10,268.52	233.38
Average	324	66.54	1.51	2,053.70	46.68
		± 3.77	± 0.01	± 116.32	± 0.26

[a] One cavan of palay is equivalent to 44 kgm. (The Bureau of Agriculture standard.)

TABLE 5

Yield per hectare of the transplanted rice

LOT NO.	AREA PLANTED	ACTUAL YIELD		YIELD PER HECTARE	
	sq. m.	*kgm.*	*cavans*	*kgm.*	*cavans*
2	324	103.8	2.36	3,203.70	72.81
4	324	89.0	2.02	2,746.91	62.43
6	324	118.0	2.68	3,641.98	82.77
8	324	78.7	1.79	2,429.01	55.20
10	324	86.0	1.95	2,654.32	60.33
Total ...	1,620	475.5	10.81	14,675.92	333.54
Average	324	95.1	2.16	2,935.18	66.71
		± 4.74	± 0.11	± 149.48	± 3.32

TABLE 6

Showing maturity, average yield and cost of production per cavan

CULTURE	MATURITY	AVERAGE YIELD		COST	
		324 sq. m.	Per Ha.	Per Ha.	Per cavan
	days	*cavans*	*cavans*	*pesos*	*pesos*
Broadcast	156	1.51	46.68	97.83	2.09
		±0.01	±0.26		
Transplanted ...	162	2.16	66.71	130.33	1.95
		±0.11	±3.32		
Difference	6	0.65	20.03	32.70	.14
		±0.11	±3.33		

INFLUENCE OF AMOUNT OF FERTILIZER IN SOIL ON GROWTH OF RICE PLANT AND ON COMPOSITION OF ITS LEAVES [1]

MARIANO F. SORIANO

WITH SIX TEXT FIGURES

INTRODUCTION

Literature reports the unusual development of the rice plant when liberally supplied with nitrogenous fertilizers, such as ammonium sulfate and potassium nitrate. A heavy application of ammonium sulfate fertilizer usually tends to promote the production of a heavy top, with dark green leaves, and a low yield of grain.[2] Its influence on the development of the roots has also been studied. The influence, however, of the fertilizers on the composition of the leaves is not yet understood. It appears that although the different parts of the body of the rice plant have been analyzed chemically, literature on the composition of these parts as influenced by the rates of application of fertilizers is still wanting.

The rather extensive literature prior to 1920 on the influence of mineral salts and commercial fertilizers on rice plants was reviewed by Espino (1920). Owing to lack of space and the fact that Espino's work is easily accessible, further review of the same papers was deemed unnecessary at the present time. However, the few papers on the rice plant that have appeared since 1920 have been studied for incorporation in this paper.

Espino (1920) found that young rice plants supplied with culture solutions containing nitrogen as nitrates were stunted in growth and extremely chlorotic. But when ammonium sulfate was supplied in addition to a nitrate, the plants attained normal growth and development, indicating that nitrogen as ammonium is essential. Espino made further studies to determine whether nitrate nitrogen could be entirely eliminated without any harmful effects on the young rice plants. From preliminary studies made in 1920, Espino found

[1] Thesis presented for graduation, 1931, with the degree of Bachelor of Science in Agriculture, from the College of Agriculture No. 424; Experiment Station contribution No. 974. Prepared in the Department of Plant Physiology under the direction of Dr. Rafael B. Espino.

[2] From unpublished data in the files of the Department of Plant Physiology, College of Agriculture.

that the young rice plants deprived of nitrate nitrogen, although rather tall, showed a characteristic drying of leaf tips. This result was decidedly confirmed by the results obtained from a more critical study made later by Espino and Estioko in 1928.

Trelease and Paulino (1920) found that the best yield of rice was obtained from the cultures that were supplied with ammonium sulfate fertilizer. The other fertilizers tested proved not as beneficial to the rice plant. Kelley (1911) also found that the effects of ammonium sulfate on rice plants were beneficial. He found that ammonium nitrogen was more beneficial to rice plants than the nitrate nitrogen alone.

Macasaet (1927), from his study of the relative nutritive efficiency and relative toxicity of different salts supplied singly in solution to young rice plants, found that the potassium nitrate proved harmful to the plant. The ammonium sulfate, however, was rather beneficial.

The root system of the rice plant was also studied in relation to the rate of application of fertilizers. Libatique (1930) reported that with an increase in the application of ammonium sulfate to rice plants grown in pots containing clay-loam soil, a corresponding increase in the yield of top and in the intensity of greening of the leaves was observed. The latter condition, Libatique further reported, was always accompanied by a poor root development.

Obviously, literature on the influence of the rates of application of commercial fertilizers on the formation of chlorophyll, dry matter, ash, and moisture contents of the leaves of the rice plants of different ages is still wanting. To contribute to our little knowledge on rice nutrition, the present study was undertaken. Incidentally, quantitative data on the yields of tops and of roots of rice plants at different stages of development as influenced by the rates of applications of the fertilizers are also presented in this paper.

The work was conducted in the Department of Plant Physiology of the College of Agriculture. The earlier cultures were carried in pots from April 25, 1929 to June 25, 1929; the later cultures from October 13, 1930 to January 2, 1931. These were used for the determination of the various contents of the leaves of the plants.

MATERIALS, METHOD AND RESULTS

The plant

Lowland rice plants, variety Ramai were used in this study. Seeds obtained from the Department of Agronomy were planted in each pot. When the young plants were about three centimeters high.

two plants of apparently uniform development were selected and left in the pot, and the other plants discarded. Then, the fertilizers were applied to the cultures.

Soil and fertilizers used

Clay-loam soil was used. Empty petroleum cans were used as pots; each was filled almost to the brim with the soil, previously well pulverized and thoroughly cleaned of other solid bodies.

Two kinds of fertilizers—ammonium sulfate and potassium nitrate, were used, They were used separately and were applied to the soil in different amounts six days after sowing when the plants were about three centimeters high. Immediately after the application of the fertilizers, the plants were treated as lowland rice by submerging the soil in water, and keeping it in that condition until the end of the experiment.

Preliminary cultures

Two main sets of cultures were first studied. For convenience in description, these sets are here designated as the ammonium sulfate set and the potassium nitrate set. The ammonium sulfate set consisted of six different types of cultures; each was run in duplicate. The cultures were started on April 25, 1929, supplied with ammonium sulfate in amounts as indicated in tables 1 and 2. When the plants were thirty days old, that is, on May 25, 1929, they were harvested and data were gathered under the following criteria: (*a*) number of culms, (*b*) number of leaves, (*c*) dry weight of tops, (*d*) dry weight of roots, and (*e*) external appearance of plants. These data are given in table 1.

The remaining cultures of the ammonium sulfate set were run for another period of thirty days. At the end of this period, that is, when the plants were sixty days old, the cultures were harvested. This was on June 25, 1929. The data from this set were gathered under the same criteria of results as those used for the previous harvests, and are shown in table 2.

The potassium nitrate set had the same number of culture types, six, which were run in duplicate. The cultures received potassium nitrate fertilizer in amounts as indicated in tables 3 and 4 and were started on April 25, 1929. At the end of thirty days, that is, on May 25, 1929, the first harvest was made. The data that were obtained under the different criteria are given in table 3. These data were obtained from the six different culture types, each represented by one culture.

The remaining cultures were further continued until the plants attained the age of sixty days, when they were harvested. Data under different criteria were gathered, and are recorded in table 4.

Cultures for analytical work

Two more sets of cultures were conducted. For convenience in description, these are also designated in this paper as the ammonium sulfate set and the potassium nitrate set. Six different culture types under the ammonium sulfate set were studied. Culture I was the control culture and received no ammonium sulfate fertilizer. The other five culture types, cultures II, III, IV, V, and VI, each was supplied with a certain amount of the fertilizer (*see* table 5).[3] The cultures were started on October 13, 1930. One culture of each of

Fig. 1.—Rice plants 30 days old grown in clay-loam soil to which ammonium sulfate fertilizer was added in different amounts: Cultures, I (control) no fertilizer; II, 2.72 grams; III, 5.43 grams; IV, 10.87 grams; V, 21.74 grams; and VI, 43.48 grams of ammonium sulfate.

the six different culture types was harvested on November 13, 1930, when the plants were 30 days old. Various analyses of the constituents of the leaves of the plants were made. Data under the different criteria, that is, under (*a*) chlorophyll extract, (*b*) dry matter in leaves, (*c*) moisture contents of leaves, (*d*) ash contents of leaves, and (*e*) external appearance of plants, were gathered (*see* table 5). At the time of harvest the plants were photographed (*see* fig. 1).

---

[3] The complete data on these six cultures and also data for the six cultures under potassium nitrate were recorded and are filed in the Department of Plant Physiology. The data for the ammonium sulfate are summarized in table 5; for the potassium nitrate in table 6.

Similar data obtained from cultures belonging to the ammonium sulfate set for the rice plants 60 and 80 days old were also gathered (*see* table 5). At the time of harvest the 60-day old plants as well as the 80-day old plants were separately photographed (*see* fig. 2 and 3).

The data for the six cultures that received different amounts of potassium nitrate fertilizer and were used for the determination of the percentage (*a*) of chlorophyll extract, (*b*) dry matter in leaves, (*c*) moisture contents of leaves, and (*d*) of ash, together with the notes on the "external appearance of plants" are summarized in table 6. These three sets of cultures, at the time they were harvested, were separately photographed (*see* fig. 4, 5, and 6).

Fig. 2.—Rice plants 60 days old grown in clay-loam soil to which ammonium sulfate fertilizer was added in different amounts: Cultures, I, (control) no fertilizer; II, 2.72 grams; III, 5.43 grams; IV, 10.87 grams; V, 21.74 grams; and VI, 43.48 grams of ammonium sulfate.

The cultures were kept free from weeds. From time to time water was poured on the soil in the pots and the plants were carefully examined for any insect or fungous disease. Whenever discovered, the pests or diseases were carefully removed or treated. The cultures were so arranged in the field that the amount and intensity of sunlight was equally supplied to all the plants.

How data were obtained

The data from the two main sets, here called "preliminary cultures" to distinguish them from the cultures that were employed for the analytical studies, were gathered as follows:

External appearance of plants. From time to time during the experimental period, the plants were observed for any striking peculiarities. But the final observation was made at the time of harvest.

Number of culms. The culms or stems produced by the two plants in each culture were counted at the time of harvest. The actual numbers were reduced to relative values. The actual value obtained from culture VI which received the highest application of ammonium sulfate was arbitrarily taken as 100; the other actual values were reduced relatively to this assumed highest value.

Number of leaves. The leaves produced by the two plants in each culture were counted. The actual values thus obtained were reduced to relative values, following the method employed in determining the relative values under the preceding criterion of results.

Dry weight of tops. At the time of harvest the whole plants were pulled up and the tops were cut off at the point of connection with the roots. Then, the tops were dried in an oven to constant weight and the weight of the tops from each culture was determined by means of a sufficiently sensitive balance. The actual values thus obtained were reduced to relative values following the scheme referred to above.

Dry weight of roots. After the tops were cut off the roots were carefully removed from the soil in the cans, washed with water and dried in an electric oven to constant weight. The actual values thus obtained were reduced to relative values, following the method of computation used in obtaining the other data in relative values.

The data from the studies of the composition of the leaves were obtained and computed as follows:

Percentage of chlorophyll extract. A sample of the fresh leaves weighing 3 grams from 30-day old plants, 9 grams from the 60-day old plants, and 7 grams from the 80-day old plants, were analyzed. From this sample, alcoholic chlorophyll extract was made by the following process. The sample was cut into small pieces. The pieces were placed in a beaker containing water and boiled just long enough to kill the protoplasm in the sample. It was then cooled. After cooling, the sample together with the little water in which the pieces were boiled was put into a bottle containing alcohol. The bottle was stoppered and allowed to stand for a couple of days. To facilitate the extraction of chlorophyll the sample was ground in a mortar. The macerated material was placed again in the bottle of alcohol. To make extraction of chlorophyll thorough, the sample was repeatedly stirred in the alcohol. The extract was filtered, separating the chlo-

rophyll solution from the pulpy materials, which were washed repeatedly with alcohol until the mass lost its original green color. The green filtrate, or the alcoholic chlorophyll extract, was distilled. When the volume of the filtrate was very much reduced, owing to the distillation or removal of the alcohol, it was carefully put into a small flask of known weight. The alcohol in the remaining filtrate was further evaporated and the flask was placed in a water-bath. The water was also evaporated, and when the chlorophyll extract was completely dry, its dry weight was determined. This method was followed in the extraction of chlorophyll from the samples of leaves of the plants from the different cultures.

Dividing the weight of the dry sample of chlorophyll extract by the original weight of the fresh sample, and multiplying the quotient by 100 gives the *percentage of the chlorophyll extract.*

Percentage of dry matter. The data under this criterion were obtained as follows; a small sample of fresh leaves was prepared and afterward dried in the oven. The dry weight of the sample was determined. Dividing the weight of the dry sample by the weight of the original fresh sample, and multiplying the quotient by 100 gives the *percentage of dry matter of the leaves.*

Percentage of moisture in leaves. Dividing the amount of moisture in the sample (determined after subtracting the weight of the dry sample from the weight of the fresh sample, and multiplying the quotient by 100 gives the *percentage of moisture in the leaves.*

Percentage of ash. The dry matter in each sample (obtained in connection with the determination of the percentage either of moisture or of dry matter) was incinerated, or burned to reduce it to ashes. The amount of ash obtained was weighed in an analytical balance. Dividing the weight of ash by the weight of the dry matter in the sample, and multiplying the quotient by 100, gives the *percentage of ash in the leaves.*

DISCUSSION OF RESULTS

Effects of sulfate of ammonia or of nitrate of potash on the growth and development of various plants are fairly well known. But, the major part of this study was *on the influence of the rates of application of ammonium sulfate or of nitrate of potash on the formation of chlorophyll, dry matter, ash, and moisture contents of the leaves* of the rice plants of different ages. It is on this point that the merit, if any, of this paper should be judged. Discussions of results on other aspects are made only incidentally.

Effects of sulfate of ammonia upon development of 30-day and 60-day old rice plants

Confirming previous reports, sulfate of ammonia had a characteristic influence on the growth and development of rice plant. This fertilizer tended to produce a heavy top possessing characteristic dark green leaves. At the age of 30 days, the plants showed the beneficial effects of the fertilizer. The fertilized plants appeared more vigorous than those in the control culture which did not receive any fertilizer. However, at this age or younger, the manured cultures did not show appreciable differences in state of development (*see* fig. 1.). As the plants grew older and older the developmental differences became more and more striking, (*see* fig. 2). The leaves

Fig. 3.—Rice plants 80 days old grown in clay-loam soil to which ammonium sulfate fertilizer was added in different amounts: Cultures, I (control) no fertilizer; II, 2.72 grams; III, 5.43 grams; IV, 10.87 grams; V, 21.74 grams; and VI, 43.48 grams of ammonium sulfate.

of the fertilized plants became a darker green, while those in the control cultures remained pale green.

The data in tables 1 and 2, show that the rice plants at 30 days of age did not have the maximum number of culms; neither did they have the maximum number of leaves. As the plants grew older, tillering increased. Consequently, more culms and more leaves were found when the plants had attained the age of 60 days. At 30 days of age, the maximum yields of culms and of leaves were not in culture VI to which the maximum amount of sulfate of ammonia tested (43.48 grams) was added, but in cultures IV and V. These two cultures received 10.87 and 21.74 grams of ammonium sulfate, respectively (*see* table 1). But, at the age of 60 days, the highest yield

(*see* table 2) of culms and the highest yield of leaves were found in culture VI to which the maximum amount of the fertilizer tested was added.

Interesting as they may be, the data just presented are no better than those under the criteria on (*a*) dry weight of top, and (*b*) dry weight of roots. The data under these two criteria should finally and conclusively determine the relative effects of the sulfate of ammonia upon rice plants at 30 days and 60 days of age.

Examination of the data in tables 1 and 2 show that the maximum yields of dry tops of both the 30-day and the 60-day old plants were in the same culture (culture IV) to which 10.87 grams of the fertilizer were added. However, cultures III and V both gave com-

Fig. 4.—Rice plant 30 days old grown in clay-loam soil to which potassium nitrate fertilizer was added in different amounts: Cultures, I (control) no fertilizer; II, 2.72 grams; III, 5.43 grams; IV, 10.87 grams; V, 21.74 grams; and VI, 43.48 grams of potassium nitrate.

paratively high yields of tops. The yield of tops in the control culture for the 30-day and the 60-day old plants was very very low.

The yields of roots were also materially influenced by sulfate of ammonia. The control cultures of the rice plants at 30 and at 60 days of age gave equally low yields of roots as compared with those obtained from the manured cultures. Table 1 seems to show that the best root yield was obtained from culture II, the culture that received only 2.72 grams of sulfate of ammonia. As the amount of the fertilizer was increased, there appears to be a slight gradual decrease in the yields of roots from the culture tested. At the age

of 60 days, the yields of roots (*see* table 2) seem to be rather irregular and do not follow either the ascending or the descending order observed in the case of the younger rice plants, 30 days of age.

Effects of varying the amounts of sulfate of ammonia upon the chlorophyll content of leaves

By the data summarized in table 5, the chlorophyll contents of rice leaves decreased as the plants advanced in age. In the majority of the cultures tested there was about 50 per cent decrease in chlorophyll content from plants 30 days old to plants 60 days old. In the case of the older rice plants, that is, from 60 days to 80 days, the decrease reached only about 30 to 40 per cent. These observations hold true both in the fertilized cultures and in the control cultures, which did not receive any fertilizer. Culture IV, for example, which received 10.87 grams of ammonium sulfate and which produced the highest yield of top both at 30 days and at 60 days of age, contained 10.83 per cent of chlorophyll at 30 days of age; 5.51 per cent at 60 days; and 3.86 per cent of chlorophyll when the plants were 80 days old.

The data in table 5 also show that as the amount of the sulfate of ammonia in the cultures was increased, there was a gradual but steady increase in chlorophyll content in leaves. This generalization holds true whether the rice plants were 30, 60 or 80 days of age. The control cultures always had the lowest content of chlorophyll in the leaves. The highest yield of chlorophyll from all the cultures tested, irrespective of the age of the plants, was obtained from culture VI. This culture received 43.48 grams of sulfate of ammonia and produced in the leaves of the 30-day old plants 12.3 per cent of chlorophyll.

Effects of varying the amounts of sulfate of ammonia upon the dry matter content of leaves

As in chlorophyll content, the dry matter content of the leaves of the rice plants was influenced by the amount of ammonium sulfate used. Of course, as shown in table 5, unlike chlorophyll, the dry matter content of the leaves of the plants in the manured cultures was only feebly influenced by the rates of manuring. The feeble influence, as shown by the data in table 5, seems to diminish as the amount of the application of the fertilizer was increased. Of the cultures tried, the highest yield of dry matter was obtained from the leaves of the plants supplied with the smallest dose of the ammonium sulfate used, that is from culture II. This culture received

only 2.72 grams of the fertilizer. The control cultures contained slightly less dry matter in the leaves. It might, therefore, be safe to conclude that a very moderate application of ammonium sulfate promotes the production of dry matter; heavy applications appear unfavorable.

Effects of varying the amounts of sulfate of ammonia upon the moisture content of leaves

The data in table 5 also show that the percentage of moisture content in the leaves of the 30-day old rice plants studied appear to be but slightly affected by the rates of application of the sulfate of ammonia. The influence of the fertilizer on similar but older plants (60 days old) appears to be more convincing, although more moisture was found in the younger leaves than in the older. The increase in the use of ammonium sulfate was accompanied or followed by a corresponding increase in the moisture content of the leaves. In the heavily fertilized cultures, the plants became more sappy or juicy, a condition which probably accounts for the susceptibility of this plant to bacterial or fungous diseases and to insect pests.

Effects of varying the amounts of sulfate of ammonia upon the ash content of leaves

Younger rice plants (30 days old) contained more ash in the leaves than the older plants (*see* table 5). In the case of the plants of both ages, the production of ash diminished as the amount of the fertilizer was increased. At 30 days of age, the highest percentage of ash, 19.04 per cent, was obtained in culture II, which received the lowest application of ammonium sulfate tested. At the highest application of the fertilizer, (culture VI, 43.48 grams) the amount of ash in the leaves dropped to 17.02 per cent. The control culture contained 17.97 per cent of ash in the leaves.

Effects of nitrate of potash upon development of 30-day and 60-day old rice plants

At the age of 30 days, the plants in the six different cultures tried were about the same in height, although at this stage of development the control culture had the least number of culms and of leaves (fig. 4 and table 3). The highest yield of culms and of leaves was obtained from the cultures that received the maximum application of potassium nitrate. As the amount of the fertilizer was decreased there was a corresponding decrease in the number of culms and of leaves produced by the plants.

At 60 days of age (fig. 5) the cultures began to show differences in height of the plants. The control culture, that is the one which received no application of the fertilizer, had the shortest shoots. The height of the plants in the fertilized cultures increased gradually as the amount of nitrate of potash was increased. Also, in this set of cultures were found differences in the number of culms and in the number of leaves. Among the fertilized cultures, the lowest yields in number of culms and of leaves were obtained from the least fertilized pots (2.72 grams). A steady but gradual increase in the number of these structures was obtained as the rates of the application of the fertilizer were increased; the highest yields having been

Fig. 5.—Rice plants 60 days old grown in clay-loam soil to which potassium nitrate fertilizer was added in different amounts: Cultures, I (control) no fertilizer; II, 2.72 grams; III, 5.43 grams; IV, 10.87 grams; V, 21.74 grams; and VI, 43.48 grams of potassium nitrate.

obtained from culture VI, which received 43.48 grams of potassium nitrate (table 4).

The yields of tops and of roots were also favored by the application of nitrate of potash. The yields of these vegetative structures always remained low in the control cultures, much lower than the yields of the same structures obtained from any of the fertilized cultures, particularly the heaviest manured cultures both for the 30 and 60-day old plants (tables 3 and 4).

Effects of varying the amounts of nitrate of potash upon the chlorophyll content of leaves

By the data summarized in table 6, nitrate of potash seems to promote the production of chlorophyll. This is true in the case of the rice plants 30 days, 60 days and 80 days of age. As shown in

table 6, however, the 30-day old plants had higher percentages of chlorophyll content than those obtained from the 60-day or the 80-day old plants, irrespective of the rates of application of the nitrate of potash. The percentage of chlorophyll content in leaves tends to decrease as the plants grew older. For example, the leaves of the plants from the best fertilized culture (culture VI, 43.48 grams) were found to contain at 30 days of age 9.47 per cent of chlorophyll extract; at 60 days of age, 4.80 per cent, and at 80 days of age, only 3.67 per cent. The control cultures produced 7.97 per cent of chlorophyll extract from the leaves of the rice plants 30 days old; 3.97 per cent from 60 days old; 2.37 per cent from 80 days old.

Fig. 6.—Rice plants 80 days old grown in clay-loam soil to which potassium nitrate fertilizer was added in different amounts: Cultures, I (control) no fertilizer; II, 2.72 grams; III, 5.43 grams; IV, 10.87 grams; V, 21.74 grams; and VI, 43.48 grams of potassium nitrate.

Effects of varying the amounts of nitrate of potash upon dry matter content of leaves

The data on dry matter in table 6, show that the increase in the application of nitrate of potassium was accompanied by a gradual decrease of dry matter in the leaves. The data also show that irrespective of the rates of application of the fertilizer, the 60-day old plants produced higher percentages of dry matter in the leaves than the cultures of the 30-day old plants. Culture II which received the lowest application (2.72 grams) of potassium nitrate, produced 25.48 per cent of dry matter from the leaves of the 30-day old rice plants; the 60-day old plants produced more, 35.35 per cent of dry matter. The highest yielding culture (of tops and roots), that is, culture VI,

produced plants in which the dry matter content of the leaves was 22.92 per cent from the 30-day old plants, and 31.35 per cent from the 60-day old plants.

Effects of varying the amounts of nitrate of potash upon the moisture content of leaves

As may be seen in table 6, the data on percentages of the moisture content of leaves appear to run in the inverse order to those on dry matter. In the case of both the 30-day and the 60-day old plants, the lowest moisture content was found in culture II which received only 2.72 grams of potassium nitrate. As the amount of the fertilizer was increased, there was a gradual but steady increase in the moisture content of the leaves of the plants. The 30-day old plants were always more sappy, that is, they contained more water than the 60-day old plants; both plants were grown in the culture media of the same type.

Effects of varying the amounts of nitrate of potash upon the ash content of the leaves

The 30-day old plants had more ash in the leaves than the 60-day old plants, (*see* table 6). The generalization holds good in both the control cultures and the fertilized cultures, irrespective of the rate of application of the fertilizer. Of the fertilized cultures, the highest yield of ash was obtained from culture II which received only 2.72 grams of nitrate of potash. At 30 days of age, the ash content of the leaves was 19.29 per cent; whereas at 60 days the plants had 15.48 per cent of ash. As the application of the fertilizer was increased, there was a gradual but steady decrease in ash content of the leaves. This was true in both the 30-day and the 60-day old plants. The lowest yield of ash among the 30-day old plants was obtained from culture VI which received 43.48 grams of the fertilizer. The ash content of the leaves of the plants from this culture was only 18.15 per cent. From the same culture, but from the 60-day old plants, the ash content of the leaves was even less, only 12.44 per cent; this is less than the percentage of ash obtained from the control cultures, which was 18.76 per cent in the 30-day old plants and 15.19 per cent in the 60-day old.

Comparing sulfate of ammonia and nitrate of potash in their respective influences on the leaf contents of rice plants

By the data in tables 5 and 6, it appears that sulfate of ammonia and nitrate of potash have different effects on the leaf contents of

rice plants. This is particularly true in the case of 30-day old plants. At this age the percentages of chlorophyll extracts were always greater from the leaves of the plants that received ammonium sulfate than from the leaves of plants that received the nitrate of potash. Culture for culture, the difference is about two per cent higher in favor of the plants that received the sulfate of ammonia. This difference, however, was found not pronounced in the older plants, 60 or 80 days of age, although of course, the sulfate-supplied plants had more chlorophyll than the nitrate-supplied plants from similar cultures. This finding explains, in a measure, the dark green appearance of the rice plants supplied with the sulfate of ammonia.

As to the dry matter, the data in tables 5 and 6 show that there was little difference in the influence of the two fertilizers upon the plants. The slight difference, if there is any at all, appears to be in favor of the ammonium-fed plants.

The data in tables 5 and 6 also show that, with the exception of culture II, which received the smallest dose of either potassium nitrate or ammonium sulfate fertilizer, the nitrate-fed plants contained more ash than the ammonium-fed plants. By a rough estimate, the difference was about one per cent greater in nitrate-fed plants than in ammonium-fed plants.

There seems to be no striking or pronounced difference between the effects of the two fertilizers on the moisture contents of the leaves of the rice plants.

SUMMARY AND CONCLUSIONS

1. The major part of this study was on the influence of the rates of application of sulfate of ammonia and of nitrate of potash on chlorophyll, dry matter, ash and moisture content of leaves of rice plants of different ages grown in pots containing originally only clay-loam soil.

2. Other results, such as those on the influence of varying the rate of application of the fertilizers on the yield of tops and of roots, are also presented.

3. Rice plants supplied with sulfate of ammonia produced dark green leaves. As the amount of sulfate of ammonia was increased, there was a gradual but steady increase in percentage of chlorophyll content in leaves. The chlorophyll content of rice leaves decreased as the plants advanced in age. A decrease of about 50 per cent was noted from 30-day to 60-day old plants; 30 to 40 per cent decrease in plants 60 to 80 days old.

4. The highest yield of tops of rice plants 30 or 60 days old was obtained when 10.87 grams of sulfate of ammonia were added to clay-loam soil in pots. A smaller amount of sulfate of ammonia, 2.72 grams per pot, gave the highest yield of roots of rice plants 30 days old.

5. A very moderate application of ammonium sulfate promoted the production of dry matter in leaves; heavy applications appeared unfavorable.

6. Younger plants contained more moisture and less ash than the older leaves. The increase of ammonium sulfate was accompanied by a corresponding increase in moisture and a decrease of ash contents of leaves.

7. Nitrate of potash seems to promote the production of chlorophyll in rice leaves. The percentage of chlorophyll in leaves seems to decrease as the plants advance in age.

8. The yields of tops and of roots were also favored by the application of nitrate of potash. The yields of tops and of roots were always low in the control cultures, much lower than the yields of the same parts from any of the fertilized cultures, particularly the heaviest manured cultures for both the 30 and 60-day old plants.

9. An increase in application of nitrate of potash was accompanied by a gradual decrease of dry matter in the leaves. Irrespective of the rates of application of the fertilizer, the 60-day old plants produced a higher percentage of dry matter in the leaves than the cultures of the 30-day old plants.

10. Younger plants contained more water and more ash in the leaves than the older plants. As the application of potassium nitrate was increased there was a gradual but steady increase in moisture content and a decrease in ash content of the leaves.

11. The sulfate-supplied plants produced more chlorophyll in the leaves than the nitrate-supplied plants. The two fertilizers had not much difference in influence on the production of dry matter, and had not any pronounced difference in moisture content of the leaves. Excepting the 60-day old plants in culture II, the nitrate-fed plants contained more ash in the leaves than the ammonium-fed plants; the difference being about one per cent.

LITERATURE CITED

ESPINO, R. B. 1920. Some aspects of the salt requirements of young rice plants. The Philippine Jour. Sci. **16**: 455–525.

ESPINO, R. B., AND R. P. ESTIOKO. 1931. A critical study of the nutritive values of nitrate nitrogen for young rice plants. The Philippine Agriculturist **20**: 27–42. *Fig. 1–5.*

KELLEY, W. P. 1911. The assimilation of nitrogen by rice. Hawaii Agric. Exper. Sta. Bull. 24: 1–20.

LIBATIQUE, PABLO. 1931. Comparative development of roots of rice plants grown in pots containing ammonium sulfate fertilizer of different amounts. The Philippine Agriculturist **20**: 121–137. *Pl. I; fig. 1–2.*

MACASAET, E. 1932. Comparative study on the nutritive values of phosphate, sulfates, nitrates, chlorides, and carbonates of essential metals as indicated by the growth and development of young rice plants. *Abstract in* The Philippine Agriculturist **20**: 552–553.

TRELEASE, S. F., AND P. PAULINO. 1920. The effect on the growth of rice of the addition of ammonium and nitrate salts to soil culture. The Philippine Agriculturist **8**: 293–313. *Fig. 1–3.*

TABLE 1

Data obtained from 30-day old rice plants (two plants in each culture) grown in clay-loam soil in pots to which varying amounts of ammonium sulfate fertilizer were added. (Cultures were run from April 25, 1929 to May 25, 1929)

CULTURE NO. AND AMOUNT OF AMMONIUM SULFATE USED	NUMBER OF CULMS	NUMBER OF LEAVES	DRY WEIGHT OF TOPS	DRY WEIGHT OF ROOTS	EXTERNAL APPEARANCE OF PLANTS
I (Control)	35	40	28	101	Plants growing normally; leaves few, light green; roots long and whitish brown
II (2.72 grams)	88	112	122	249	Plants good growth; leaves green, narrow and few; culms few; roots long, brown white
III (5.43 grams)	106	136	142	245	Plants good growth; leaves green, quite long; culms few, light green; roots brown, long
IV (10.87 grams)	129	142	154	235	Plants vigorous; leaves quite green, many, quite broad; culms many; roots brownish white
V (21.74 grams)	140	140	153	210	Plants vigorous; leaves dark green, many; culms dark green, many; roots brown, many branches
VI (43.48 grams)	100 (34)	100 (100)	100 (5.057 grams)	100 (0.568 gram)	Plants vigorous; leaves dark green, broad; culms dark green; roots brown, numerous but short

TABLE 2

Data obtained from 60-day old rice plants (two plants in each culture) grown in clay-loam soil in pots to which varying amounts of ammonium sulfate fertilizer were added. (Cultures were run from April 25, 1929 to June 25, 1929)

CULTURE NO. AND AMOUNT OF AMMONIUM SULFATE USED	NUMBER OF CULMS	NUMBER OF LEAVES	DRY WEIGHT OF TOPS	DRY WEIGHT OF ROOTS	EXTERNAL APPEARANCE OF PLANTS
I (Control)	49	50	41	58	Plants poor growth; leaves small, gradually tapering towards tips; culms pale green; roots long, whitish brown.
II (2.72 grams)	54	62	85	125	Similar to plants in culture I.
III (5.43 grams)	59	74	124	164	Plants fair growth; leaves green, quite long, tapering gradually towards tips, culms many; roots brown.
IV (10.87 grams)	71	86	146	140	Plants growing well; leaves green, broad and long; tapering towards tips; culms many; roots brown and numerous.
V (21.74 grams)	68	84	108	155	Plants vigorous; leaves dark green, broad and long, tapering abruptly towards tips; roots brown, abundant branches.
VI (43.48 grams)	100 (118)	100 (444)	100 (77.84 grams)	100 (19.30 grams)	Similar to plants in culture V.

TABLE 3

Data obtained from 30-day old rice plants (two plants in each culture) grown in clay-loam soil in pots to which varying amounts of potassium nitrate fertilizer were added. (Cultures were run from April 25, 1929 to May 25, 1929)

CULTURE NO. AND AMOUNT OF POTASSIUM NITRATE USED	NUMBER OF CULMS	NUMBER OF LEAVES	DRY WEIGHT OF TOPS	DRY WEIGHT OF ROOTS	EXTERNAL APPEARANCE OF PLANTS
I (Control)	20	25	14	20	Plants normally developed; leaves pale green, roots long, whitish brown.
II (2.72 grams)	49	56	38	73	Similar to plants in culture I.
III (5.43 grams)	60	66	47	76	Plants good growth, leaves green, many; culms light green; roots brown, numerous and small in size.
IV (10.87 grams)	77	81	69	103	Similar to plants in culture III.
V (21.74 grams)	80	90	73	72	Plants vigorous; leaves dark green, many and broad; culms many, roots brown and numerous.
VI (43.48 grams)	100 (35)	100 (102)	100 (6.496 grams)	100 (1.23 grams)	Plants vigorous; leaves broad and dark green; culms many; roots brown, short and abundant branches.

TABLE 4

Data obtained from 60-day old rice plants (two plants in each culture) grown in clay-loam soil in pots to which different or varying amounts of potassium nitrate fertilizer were added. (Cultures were run from April 25, 1929 to June 25, 1929)

CULTURE NO. AND AMOUNT OF POTASSIUM NITRATE USED	NUMBER OF CULMS	NUMBER OF LEAVES	DRY WEIGHT OF TOPS	DRY WEIGHT OF ROOTS	EXTERNAL APPEARANCE OF PLANTS
I (Control)	51	41	33	58	Plants stunted; leaves pale green, narrow and short; culms few; roots long, whitish brown.
II (2.72 grams)	43	47	35	71	Similar to plants in culture I.
III (5.43 grams)	46	46	36	74	Plants fair growth; leaves narrow, tapering gradually towards tips; culms light green, many roots long, brownish white.
IV (10.87 grams)	54	48	44	75	Similar to plants in culture III.
V (21.74 grams)	95	78	87	115	Plants vigorous; leaves green, broad and long, tapering abruptly towards tips; culms green; roots brown, many but short.
VI (43.48 grams)	100 (74)	100 (406)	100 (116.2 grams)	100 (31.70 grams)	Plants vigorous; leaves green, broad and long, taper quickly towards tips, culms numerous, roots brown, abundant short branches.

TABLE 5

Showing data on percentages of chlorophyll extract, dry matter, moisture content, and of ash in leaves of the plants of different ages as influenced by the amounts of ammonium sulfate used. (Compiled from tables on file)

CULTURE NO. AND AMOUNT OF AMMONIUM SULFATE USED	PERCENTAGE OF CHLOROPHYLL EXTRACT			PERCENTAGE OF DRY MATTER IN LEAVES		PERCENTAGE OF MOISTURE CONTENT OF LEAVES		PERCENTAGE OF ASH IN LEAVES	
	30-day old plants	60-day old plants	80-day old plants	30-day old plants	60-day old plants	30-day old plants	60-day old plants	30-day old plants	60-day old plants
I (Control)	10.07	3.79	3.40	24.48	34.40	75.52	65.60	17.97	15.77
II (2.72 grams)	10.27	4.71	3.44	25.00	35.54	75.00	64.46	19.04	15.61
III (5.43 grams)	10.53	5.34	3.73	24.88	35.49	75.12	64.51	18.49	14.48
IV (10.87 grams)	10.83	5.51	3.86	24.96	33.73	75.04	66.27	17.97	13.75
V (21.74 grams)	12.10	6.61	4.41	24.49	31.94	75.52	68.06	17.65	11.98
VI (43.48 grams)	12.30	6.78	6.31	24.20	31.71	75.80	68.29	17.02	11.59

TABLE 6

Showing data on percentages of chlorophyll extract, dry matter, moisture content, and of ash in leaves of the plants of different ages as influenced by the amounts of potassium nitrate used. (Compiled from tables on file)

CULTURE NO. AND AMOUNT OF POTASSIUM NITRATE USED	PERCENTAGE OF CHLOROPHYLL EXTRACT			PERCENTAGE OF DRY MATTER IN LEAVES		PERCENTAGE OF MOISTURE CONTENTS OF LEAVES		PERCENTAGE OF ASH IN LEAVES	
	30-day old plants	60-day old plants	80-day old plants	30-day old plants	60-day old plants	30-day old plants	60-day old plants	30-day old plants	60-day old plants
I (Control)	7.97	3.97	2.37	25.80	33.91	74.20	66.09	18.76	15.19
II (2.72 grams)	7.57	4.11	3.13	25.48	35.35	74.52	64.65	19.29	15.48
III (5.43 grams)	8.70	4.42	3.26	24.12	33.95	75.88	66.05	19.24	15.28
IV (10.87 grams)	8.83	4.47	3.43	23.96	32.76	76.04	67.24	18.36	15.22
V (21.74 grams)	9.00	4.63	3.50	23.88	31.91	76.12	68.09	18.59	14.88
VI (43.48 grams)	9.47	4.80	3.63	22.92	31.35	77.08	68.65	18.15	12.44

ABSTRACT [1]

Acclimatization of Irish potato. VICENTE M. DAWIS (*Thesis presented for graduation, 1916, from the College of Agriculture, No. 425; Experiment Station contribution No. 975.*)—The objects of this work were to make some cultural tests at different altitudes, and to determine the seasons of planting of several standard varieties of the Irish potato. Plantings were made at three altitudes; one at 164 ft. above sea level, the so-called acclimatization plots, another at 1500 ft., and at the summit of Mount Maquiling with an altitude of about 3460 ft.

The author made two recommendations: (*a*) The soil should be mellow and if heavy, humus should be added, and proper drainage should be provided; (*b*) dry season planting should be deep, and wet season planting shallow, from 10 to 12 inches between the hills in the row, and from 20 to 30 inches between the rows were found to be practicable. Cultivating and harvesting with the use of machinery will not pay under Philippine conditions.

The results obtained from this experiment were as follows: Plantings between September and the earlier part of December for lower altitudes, and between November and February for higher altitudes of about 1500 ft. above sea level were found to be the best. Newly introduced tubers did better if planted for the first time at higher elevation, then the product of this planting at ordinary level, than when they were planted directly at lower level.

The variety I (Triumph, "Bliss's") produced fair yields of salable tubers, and the varieties II (Late Rose); III (Burbank); 4197 (The Sutton's Flourbal Potato); 4201 (Potato, Sutton's Carisbrooker Castle); 4202 (Potato, Sutton's Edinburgh Castle); 4206 (Potato, Sutton's Centenary); 4211 (Potato, Sutton's Epicure); 4213 (Potato Sutton's Harbinger), and 4217 (Potato, Sutton's Abundance) produced salable tubers but were recommended for further study by the writer. Cut tubers should not be planted in too wet or too dry soils.

F_1 (first generation) of the varieties I, II and III gave better growth and yield than that of the first planting, and F_2 produced larger tubers than those from the F_1 of these varieties.

---

[1] Abstract prepared as part of required theme work in English 3a, College of Agriculture.

There was no correlation between the size of the tubers planted and the tubers produced. Planting whole tubers was found to be better than planting cut tubers of any size. Cut tubers may be planted immediately after cutting, but germinated seed tubers gave higher yield of salable tubers in the acclimatization plots than at the higher altitudes (elevation 1500 ft.).

The worst pest of the potato plant was the spotted beetle, which occurred abundantly during July. Blight occurred only after a heavy rain or storm.

—*Abstract by Proceso E. Alcala*

KERNELS

"CORN FROM THE SHEAVES OF SCIENCE"

Of the three methods of pasture management, burning, cutting and grubbing, it was found by experiment that grubbing gives the best result in controlling the grasses not suitable for pasture and in producing the largest amount of forage. The three methods may be combined to great advantage.

To get the maximum yield of soybean the seed for planting purposes should be selected every year and allowed to burst by drying the pods in the sun.

The carbon dioxide content of the molasses bears no relation to the composition of the gums obtained from it.

Frequent cultivation is the keynote of success in the production of peanut.

With Los Baños Cantonese hens the eggs laid by young hens are decidedly the highest in percentage of fertility. The practical application of this finding is apparent.

The rate of purging of massecuites decreases with a decrease in size of crystals.

With corn, Ammo-Phos fertilizer should be applied at the rate of 50 kgm. per hectare and Leunaphos IG and ammonium sulfate fertilizers at 100 kgm. each per hectare.

The instrument known as emasculatome, if properly used, is an efficient tool in castrating large animals as oxen, carabaos, horses and goats. But when used by an inexperienced hand slips more than likely will occur.

A combination of 500 petroleum cans of manure and 500 petroleum cans of ashes will increase the yield of corn by about six cavans.

Pigeon peas (*Cajanus cajan* Linn., Millsp.) contain high amounts of the important amino acids, arguinine and lysine.

CURRENT NOTES

To begin with, it must be realized that 39 per cent of the European population of the Union of South Africa live by farming. Many people are possibly under the impression that the mining industry of the State is the largest employer of labour, but in that they are mistaken; the distinction belongs to the farming industry. Census figures indicate that 31 per cent of our adult male white population earn their livelihood by farming, while of the 18,000 boys who leave school annually, 8,500 seek employment on the farms. But of these 8,500, a large number have undoubtedly failed in the past to find satisfactory positions or to maintain themselves as farmers, through having had no training worth mentioning for their vocation. . . . Agricultural education is a pressing necessity for the future farmer, and the State realizes this. The world unemployment position has shown that farming is our most important avenue of employment, and our farming industry may not, like other industries, contribute towards the influx of unemployed to the towns. The remedy is to train farmers who will be able to retain their farms and continue in their vocation.

Farming in South Africa March, 1934

Wentworth, of New Brunswick, has found that fresh cod livers can be mixed with cocoa in such a manner that the health-promoting properties of the livers can be presented without oiliness or objectionable taste or odour. Small chocolate bars containing the equivalent of a tablespoonful of cod liver oil have been made and mixtures of cod livers with cocoa have been used for making ice-cream and milk and egg shakes. It is claimed that there is no impairment of

the livers by chemical or physical change. The Canadian experimenters have found that by their method the activity is retained for at least twelve months. The process is simple. The livers are freed from extraneous matter and finely minced after which they are mixed with cocoa in definite proportions. The resultant heavy dough is milled and the mixture, on leaving the rolls, looks just like ordinary cocoa. Apparently no rancidity occurs, which is rather remarkable. It is now being marketed as a powder and also in the form of chocolate candy bars.

(*Proceedings of the Agricultural Society of Trinidad and Tobago*, Vol. XXXIV, pt. 3.). Reprinted in *Tropical Agriculture* May, 1934.

Discussing milk and dairy products at a meeting of the Society of Chemical Industry at Armstrong College, Dr. H. D. Kay, of the National Institute for Research in Dairying, said that the pertinent question as to how far the modern cow can be quantitatively improved as a milk factory is a most interesting one. She already provides four or five times as much milk as she would in a normal lactation period with a suckling calf. During a lactation period, a good cow may give in the solids of the milk no less than three times her own (solid) weight. It is questionable whether there is any real purpose to be served in endeavoring to push this much farther.

The limiting factor may be either the length and functional capacity of the digestive system, or the secreting capacity of the mammary glands, but in any case the law of diminishing returns begins to operate at about 700–800 gal. in that for every gallon of milk produced beyond this figure, the quantity of concentrates required by the animal increase steeply, and influences more and more seriously the net cost of production of the extra gallonage.

Reprinted from the *Farmer and Stock-Breeder*, July 24, 1933
Agriculture and Livestock in India March, 1934.

We pluck the young beets and cook them, greens and all, so sweet and so tender. We pick the tiny new heads of cabbage before they are really ready, for that delicate cabbage in cream for which we have been waiting. Later, when the tomatoes begin to form, we can hardly wait until they are large enough to fry in their green state; and after they ripen we fry them, bake them, or use them for salad.

Country Gentleman May, 1934

COLLEGE AND ALUMNI NOTES

Dr. C. E. McClung, professor of zoölogy and director of the zoölogical laboratories, University of Pennsylvania, accompanied by Mrs. McClung and his research assistant, Dr. H. Irene Corey, spent three days on the College Campus, from June 25 to 27. He and his party arrived at Manila on June 24 from Tokyo where he had been a visiting professor for one year in the Keiogijuku Medical College, under the auspices of the Rockefeller Foundation.

During his stay on our Campus, Doctor McClung worked in the guest laboratory of the Department of Entomology, where the staff co-operated with him in the way of securing cytological material of short-horned locusts. In the evening of June 26 a dinner was given in honor of the visitors by the Los Baños Biological Club at Molawin Hall. This was followed by an address by Doctor McClung in the College Auditorium which was filled, windows and all, by faculty and students. The eminent professor gave his audience the privilege of witnessing with him through a kaleidoscopic perspective of thirty years the drama of the birth and husky growth of the now generally accepted theory of the rôle of chromosome in sex-determination, of which he is the famous foster-father.

The party left the Philippines on June 28 on the way to Java and other Oriental countries and to Africa for further material.

Attorney Jose Cojuangco, Jr., Manager of the Paniqui Sugar Mill, Inc. and recently elected representative from Tarlac donated another three-roller mill and a steam engine to the U. P. Sugar Mill. These will be used by the College of Agriculture for instructing future sugar technologists.

Mr. Isabelo Hilario of Bayambang, Pangasinan, one of the heavy purchasers of cassava cuttings from the College of Agriculture, sent his foreman to the College on June 18, 1934 to confer with Dr. N. B. Mendiola about the different varieties of cassava that he planted on his farm a year ago. The foreman obtained cuttings of Mandioca Basiorao, Aipin Valenca, Mandioca Sao Pedro Preto and Kapo White varieties to be used in checking up the varieties in Mr. Hilario's plantation.

Mr. Nicolas Alviro of Carmay, Puerto Princesa, Palawan was a recent campus visitor. He conferred with Dr. Pedro A. David of the Department of Agronomy about the culture of lumbang and purchased lumbang seeds for planting materials.

Dr. F. O. Santos, Head, Department of Agricultural Chemistry is giving a series of lectures this semester on nutrition in the School of Public Health Nursing of the University of the Philippines.

Dr. N. B. Mendiola, Head of the Department of Agronomy has been elected by members of the faculty and employees of the University of the Philippines who are contributors to the University Retirement and Pension Fund as one of the two alternate members of the Board of Directors of the Fund.

The ninety-first regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Poultry Building, College of Agriculture, on Thursday, June 28, 1934, at 7:30 p. m.

The following papers were read and discussed:

"Methods of propagation of the macopa, *Eugenia javanica* Lam. with special reference to use of other species as stocks"

By Dr. L. G. Gonzalez

"Studies on the physical qualities of the hen's egg: I. Observations on new-laid Los Baños Cantonese eggs."

By Dr. F. M. Fronda and Mr. D. D. Clemente

Paper was read by Doctor Fronda.

"Twelve years of improvement of Philippine pineapple in the College of Agriculture"

By Dr. N. B. Mendiola, Dr. J.M. Capinpin and Mr. T. M. Mercado

Paper was read by Doctor Mendiola.

Mr. Teodoro Gonzalez '34 recently visited the College. He is managing the family farm and the farm of Mr. A. Carandang '20 of the Calamba Sugar Estate, both in Tanauan, Batangas. Mr. Gonzalez conferred about his work with Mr. Vicente Aragon of the Agronomy Department.

Mr. Pedro B. Saulo, a student in the early days of this College spent a day on the Campus recently. Mr. Saulo is managing his farm in Sta. Rosa, Aliaga, and one also in San Antonio, Nueva Ecija. This is Mr. Saulo's first visit to the College since he left in 1914. He

was much surprised to see the improvements and changes. Besides our farm crops projects he was interested in our manufacture of toyo, cassava starch and soap.

In the February number of the *Queensland Agricultural Journal* a brief summary is given of the thesis "A comparative study of corn and molasses as basal feeds for swine" by Diodati R. Gochangco which appeared in the January, 1933 issue of THE PHILIPPINE AGRICULTURIST.

The Mimics, Assistant Professor Cole, director, held the first meeting of the year in the evening of July 12. Nineteen old members were present. This leaves six vacancies to be filled as the number of members is limited to twenty-five.

The officers elected for the semester are:

President	Abel Silva
Vice-President	Gabriel Flores
Treasurer	Demetrio Miranda
Secretary	Flaviano Olivares
Stage Manager	Rasuman Macalandong
Business Manager	Jose Borromeo
Property Custodian	Raul Arana
Reporter	Melovico Rana

The members organized into groups to carry on the pageant work for the coming twenty-fifth anniversary of the College of Agriculture. Much enthusiasm was shown both for the organization and for the anniversary celebration on October 10, Loyalty Day.

IN MEMORIAM

RAFAEL B. ROTOR, B. Agr. '28; B. S. A. '30; B. S. S. T. '33.

Graduate Assistant (Rural Economics) College of Agriculture June 4, 1928–October 14, 1933. Chief Chemist, Paniqui Sugar Mills, Paniqui, Tarlac, October, 1933–July, 1934.

Manila, August 1, 1934

CAMPUS GATE

This gate was a gift from the University Student Council

ON OUR SILVER ANNIVERSARY [1]

On June 14, 1909 the College of Agriculture opened its doors. This statement is more figurative than real as the College had no buildings, and much less doors to open. It was not until the following October that the College moved into its first quarters on its present location. These quarters, then designated as the "temporary building", was a structure of bamboo and wood, with a roof of corrugated iron. This building is still standing, although like the proverbial jack-knife many of its parts have been replaced; it now houses the Department of Rural Economics and the Post Office. In the period intervening between the opening and the occupancy of this first building, classes met in the homes of the faculty and in borrowed military tents at the army post in the village of Los Baños.

From this humble beginning the growth has been steady, so that now the institution can lay claim to being the best organized agricultural college in the tropics of the world, and it is properly equipped to discharge the various tasks that have by law been assigned to it, and in addition, others that necessity and public demand have created.

The College of Agriculture was the first collegiate unit established under the University of the Philippines. Two other colleges, medicine and law, previously established as independent units were later incorporated in the University. As a university college, the avowed task of the institution from the beginning was to give instruction of collegiate grade in agriculture. The faculty soon realized, however, that local information on agriculture was sorely wanting, and whether authorized by law or not, it soon found itself active in the task of experimentation to unearth the facts necessary for the instructional work. In 1915 this function was legalized through the establishment of an agricultural experiment station as an adjunct to the College. This establishing act did little more than give legal sanction to work already being performed by the faculty; and provide funds for the purchase of additional land, some experimental animals, and the construction of some buildings. No specific funds for personnel nor for the operation of the experiment station were appropriated then or thereafter. The experimental

[1] General contribution from the College of Agriculture, No. 411.

work has always been in the hands of the teaching personnel, with advanced students coöperating. While this situation was largely fortuitous, it is apparently also very fortunate. In his annual report for 1932–33, President James Bryant Conant of Harvard University states the following:

> Learning must be advanced as well as perpetuated. Indeed, in the last analysis it is only by advancing learning that it is possible to perpetuate it. When knowledge ceases to expand and develop, it becomes devitalized, degraded, and a matter of little importance to the present or future. The community loses interest, and the youth of the country responds to other challenges. Able young men enlist in an enterprise only if they are persuaded that they, too, may contribute by creative work. A zest for intellectual adventure should be the characteristic of every university. In the future as in the past, our teachers must be scholars who are extending the frontiers of knowledge in every direction. I hope there will never be a separation of our faculty into those who teach and those who carry on creative work. No line should be drawn between teaching and research. Our strength in the past has lain in the fact that the spirit of scholarship has pervaded our teaching and our scholars have seen the importance of perpetuating the ideals of scholarship as well as advancing knowledge in their own specialty.

At the end of the academic year 1933–34 the College had published 948 Experiment Station Contributions, 397 General Contributions more or less related to agriculture, and, in addition under its auspices had published 11 miscellaneous papers consisting of contributions by men not connected with the College and translations by members of the faculty of important articles of local interest. Its most important publication medium, THE PHILIPPINE AGRICULTURIST, is now in its twenty-third volume. The twenty-two volumes published so far "form the best collection in print of original investigations on Philippine agriculture".

It appears to be a little more than a mere coincidence that of 69 names listed from the Philippines in the last edition, 1933, of American Men of Science, 30 have been connected or are still connected with the College as members of its faculty or as students, and that 26 out of 50 Filipinos among these have been or are members of the faculty and alumni of the College, and that of 114 persons appointed by the Governor-General in March, 1934 as charter members to constitute the National Research Council of the Philippine Islands 29 are or have been similarly connected with the institution. The claim of friends and well-wishers of the College that Los Baños is now the cradle of natural science in the Philippines does not appear to be altogether unfounded.

At the completion of the eighteenth year of the College the writer[2] in a reminescent mood traced the early history of the College and related the important part played by the early personalities connected with it. Again in 1929[3] he narrated the material development of the institution. Not enough years have elapsed since then to necessitate the bringing up to date the history of the College. History written with so limited a perspective is likely to be warped, especially since a large majority of the active participants of only seven years ago are still with us.

Even the briefest story about the past of the College would be incomplete, however, without a passing mention of two characters

For years this building bore the name "The Temporary Building". It has been the home of many activities.

who have left the impress of their personalities on the institution; Dr. Edwin Bingham Copeland, its founder and first dean from 1909 to 1917, and the late Professor Charles Fuller Baker who succeeded him as dean and held the office from 1917 to 1927. Every worth while institution develops in the course of its life some characters which become distinctly its attributes in a manner similar to the distinguishing characteristics of a person. In this College these

[2] GONZALEZ, B. M. 1927. In retrospect. The Philippine Agriculturist 16: 121–124.

[3] GONZALEZ, B. M. 1929. The first twenty years of the College of Agriculture. The Philippine Agriculturist 18: 241–266.

have taken the form of service to the state and the search for truth. These are the living ideals that constitute the personality of this College and that may readily be identified as the guiding spirit in its everyday life. We owe their origin to the two leaders who implanted them and nurtured them with painstaking care throughout their period of service with the institution.

As a teaching and as a research institution the College has two essential products that it desires to present to the public at this time for an impartial judgment as to how well, or how badly, it is discharging its commitments. On one hand, it presents the rôle the graduates are playing in the development of the country, both in the promotion of agriculture through governmental agencies and through private enterprise, and on the other hand its work in the unearthing of essential facts which form the basis of economical agricultural production. The present number of THE PHILIPPINE AGRICULTURIST is dedicated to the presentation of the accomplishments of the College along the two lines indicated.

B. M. GONZALEZ
Dean, College of Agriculture

Act No. 2730 of the Philippine Legislature, February 15, 1918, establishing the agricultural Experiment Station at the College of Agriculture and appropriating ₱125,000 for the purchase of land, experimental animals, two laboratory buildings and a hog barn, enabled this institution to launch an important activity in the service of the country.

Work remains, I believe, the primary educator of the race, the aorta of education; and poor, essentially uneducated, is that youth whose opportunities have opened to him every door except the door of labor.—WILLIAM ERNEST HOCKING.

FACULTY COLLEGE OF AGRICULTURE, 1934

The valuable attributes of a research man are conscious ignorance and active curiosity.—W. R. WHITNEY.

CONTENTS

All photographs, except those by Robert L. Pendleton, by Photographic Division, Department of Soils.

THE CAMPUS AND EXPERIMENT STATION LANDS OF THE COLLEGE OF AGRICULTURE

STUDENT BODY, 1934, COLLEGE OF AGRICULTURE

AGRICULTURAL CHEMISTRY IN THE SERVICE OF THE STATE [1]

F. O. SANTOS
Of the Department of Agricultural Chemistry

The Department of Agricultural Chemistry of the College of Agriculture was established not solely for the teaching of chemistry as applied to agriculture but also for the purpose of making investigations the results of which would be of benefit in promoting the welfare of the people and the prosperity of the country. In the following pages some of the results which have been attained and which are considered of immediate and practical value are given.

CHEMICAL ANALYSIS OF FOODS AND FEEDS

As soon as advanced teaching and investigation work were started in the Department, the lack of data on the chemical analysis of native agricultural materials was felt. Hence, it was natural that most of the earlier work centered on the chemical analysis of agricultural products such as foods and feeds. For the convenience of workers, the data thus obtained and data from other laboratories were compiled and published under the title, "The Proximate Chemical Analysis of Philippine Foods and Feeding Stuffs: I, II, III and IV", "The Chemical Composition of Philippine Food Materials" and "Amount of Nutrients in Philippine Food Materials". In these publications may be found the proximate proteins, fats, carbohydrates, mineral and water content of most of our foods, feeding stuffs and other agricultural products (Adriano, 1925, 1929; Adriano, Ramos and Ynalvez, 1932; Adriano and de Guzman, 1932; Santos and Adriano, 1928; Santos and Ascalon, 1931).

In the analysis of sweet potato, two varieties, Guinarosa 1070 and Leyte 1080 were found to be sweeter than the others; Tinogabong 1078, Sinamporado 1071, Leyte 1081 and Caigbao 1068 were found to be high in starch content (Labayen, 1914).

In fish, it was found that proteins constitute one-fifth of the edible portion, and that fish which are somewhat cylindrical in shape contain the higher percentage of edible portion. On an average, shellfish contain only 40 per cent edible portion. Of the shellfish, shrimp is the highest in proteins; balakwit (*Strombus cana-*

[1] General contribution from the College of Agriculture No. 412.

rium Linn.), bitubituin (unidentified), caligay (snail, unidentified), cohol (*Ampullaria vittata* Reeve.), susong dagat (*Cerithium vertagus* Linn.), and oysters are high in minerals (Balagtas, 1928; Etorma, 1928).

Eggs offered for sale in the markets are usually of varying ages, hence, it was considered important to know whether appreciable changes in their chemical composition take place in holding. It was found that both fertile and infertile Cantonese eggs had practically the same amount of moisture, ash, proteins and fats at all ages (Legaspi, 1933).

In the study of banana for minerals, the varieties Pitogo, Butuan, Lacatan, Tiparot and Saba were found to be high in calcium; Pitogo, Buñgulan, Saba, Latundan and Ternate in iron; Pitogo, Saba, Lacatan, Latundan and Tiparot in phosphorous (Martinez, 1932).

Different varieties of rice sent in by faculty members and advanced students for analysis were found to vary greatly in mineral content. The variety Cruz was found to have the highest mineral content. Bulandi, Susongsong, Inasinag, Piling Baybay and Lumbang varieties were found to be high in mineral also.

Pechay (*Brassica cernua* F. and H.), lettuce, tango (*Chrysanthermum coronarium* Linn.), cucumber, beets and ampalaya (*Momordica charantia* Linn.) were found to be good sources of iron; tango, lettuce, cabbage and pechay, of manganese; and tango, pechay, mustard and condol, of copper (Gonzalez, 1933).

Phytin is a good source of phosphorous. Lacatan banana, coconut, mabolo (*Diospyros discolor* Ww.), pineapple, peanut, carrot, sugar beet, ampalaya (*Momordica charantia* Linn.), cucumber, upo (*Lagenaria leucantha* Rby.), onion, patola (*Luffa acutangula* Rxb.), sitao (*Vigna sinensis*, var. sesquipedalis Fruw.), sugar pea and tomato were found to be high in phytin (Bagaoisan, 1930).

Nutrition studies indicate that the common Philippine dietary is deficient in calcium (Roxas and Collado, 1922). Philippine cereals, tubers and bulbs were found to be poor in this nutrient. The following materials were found to be high in calcium: tinapa (smoked fish), tuyo (dried fish), clams, oysters, orange, mandarin, breadfruit, eggs, cheese, milk, beans, endive, malungay leaves (*Moringa oleifera* Lam.) and himbaba-o (*Allaeanthus luzonicus* (Blanco) F.-Vill.) (Adriano and Tavanlar, 1925).

Cases of poisoning of cattle by the leaves and pods of *Sibatsing gubat*, a wild variety of patani (*Phaseolus lunatus* Linn.), and of men by Bule patani, a wild black variety, are not infrequent in the

Philippines. Death is generally attributed to the poison, prussic acid, which is found in beans in varying amounts. Both the wild and semi-wild varieties of patani contain this poison in amounts to make them unsafe for consumption. These patani when boiled in vinegar for two hours, and then treated with lime to neutralize the sour taste and then washed with water, were relished by guinea pigs and had no apparent bad effect on them. Hence, if the wild and semi-wild patani must be eaten they should be boiled thoroughly in vinegar and the liquid thrown away; then they should be treated with lime water, and then washed thoroughly in boiling water (Serrano, 1933).

APPARATUS AND METHODS OF ANALYSIS

Modified ammonia bulbs. One of the frequent sources of error in nitrogen determination is the loss of ammonia that often occurs during the addition of strong alkali to the digested samples. To eliminate this source of error an Improved Device (Adriano, 1932) for adding the saturated alkali was made. With the use of this device results more consistent and higher than those from the ordinary procedure were obtained.

Also, for eliminating the same source of error a Modified Ammonia Bulb (Villanueva, 1933) was designed and made from glassware easily obtainable in a chemical laboratory. By the use of this bulb the following advantages are derived:

a. No great care is required to prevent the loss of ammonia through the improper handling of the flask containing the sample to be analyzed.

b. The steam passing through the steam-alkali tube maintains the temperature of the vapors in the ammonia bulb at a rather high temperature, thereby preventing rapid condensation.

c. The heat of reaction between the acid mixture and saturated alkali is readily utilized as it takes just a few seconds to turn on the steam.

d. There is no smearing of the mouth of the Kjeldahl flask with alkali when it is added. Such smearing sometimes prevents the perfect fitting of the rubber stopper to the flask.

Prussic acid determination. Prussic acid is commonly found in roots and tubers. In the breeding and selection of special varieties of tubers hundreds of tests for this poison had to be made within a short period of time. So a short method which not only detects this poison but which also gives a quantitative measure was needed. Based on Guignard's procedure, an approximate quantitative

method was devised. The intensity and length of coloration which the prussic acid in a definite amount of sample gives on especially prepared picric acid paper was made the basis of estimation (Adriano and Ynalvez, 1932).

Inversion by phosphoric acid. The use of hydrochloric acid in the optical method of estimating sucrose adopted by the Hawaiian Sugar Technologists Association and the Association of Official Agricultural Chemists introduces an error as the readings are taken in different pH concentrations. Also, in the presence of levulose, as in cane syrup and molasses, the method gives erroneous re-

Fig. 1.—An assembly of apparatus, with local improvements, for biochemical studies: *A* improved device for adding alkali; *B* a modified ammonia bulb.

sults. Paine and Balch's method of sucrose hydrolysis by the use of invertase eliminates this error but the method is long. Experiments in our laboratory showed that this error was eliminated by using phosphoric acid instead of hydrochloric acid in the hydrolysis and by taking the direct reading in the same acid concentration. Results obtained by this method were closer to the results obtained by hydrolysis with invertase than by hydrolysis with hydrochloric acid (Soliven, 1934).

Alkaline permanganate oxidation of glucose, starch and lactose. The copper reduction method for these constituents is time con-

suming. In perishable samples and when many analyses have to be made quickly the need for a shorter method is almost imperative. To fill this need the alkaline permanganate oxidation method was proposed. In this proposed method the preparation of the sample is the same as in the usual method; but the time consuming filtration by suction, washing and drying of the cuprous oxide as required in the usual method is eliminated (Quisumbing, 1920; Adriano, 1920).

Modified confirmatory test for aluminum. The confirmatory test for aluminum in accordance with the Thenard test as given by Noyes is not quite satisfactory for class exercises for the test requires much practice and great dexterity. In the Noyes scheme the precipitated aluminum hydroxide is burned with the filter paper and the blue residue confirms the presence of aluminum. The presence of sodium interferes with the test for it fuses with the ash of the filter paper and thereby lessens the sensitiveness of the test. If the ignition is prolonged the ash drops to pieces, and the test is spoiled. In the method worked out in our laboratory a few asbestos threads are placed at the cone of the filter paper and it is these threads that are ignited rather than the filter paper. It was found that this test is more sensitive than the usual one and it is not necessary to wash the precipitate free from sodium salts. Ignition is shortened (Pañganiban and Soliven, 1928).

NUTS AND OILS

The coconut is the most valuable nut in the Philippines. A study of the changes occurring in it during the ripening process showed that at first there is an accumulation of invert sugar and amino acid in the milk; then the sucrose appears in the milk and its specific gravity increases; and finally there is a sudden rise in the content of oil in the endosperm (Gonzalez, 1914).

Although lipase plays an important rôle in the germination of oily seeds, its occurrence in the germinating coconut was a matter of dispute. This Department has verified the assertion that lipase is really present in the germinating coconut; that it works well in a partially neutral medium and that magnesium oxide is an excellent agent for removing the free fatty acids formed (Roxas, 1914).

Copra meal is one of the important by-products in the coconut oil industry. It is extensively used as a feed. Studies in this Department have shown that copra meal is rich in the amino-acids

necessary for maintenance and growth (Santos, 1920). It also contains the following carbohydrates; sucrose, raffinose, galactose, pentoses, fructose, glucose, cellulose, pentosans, starch, dextrin and galactan (Caray, 1921). When fed alone or even when supplemented with purified food, copra meal was found to be highly constipating to guinea pigs and poor in anti-scorbutic vitamin (Derecho, 1921).

When copra meal formed 37 per cent of an otherwise complete ration it was promotive of health, vigor and growth of guinea pigs and albino rats, but when it formed 75 to 85 per cent of the ration, it was deleterious to guinea pigs and fatal to albino rats. These effects were produced irrespective of the oil content of the copra meal (Sulit, 1926).

On account of its varied and important uses, oil is one of the important articles of commerce. At present only coconut and lumbang oils are known in the Philippine market. This Department has carried on investigations on the possibility of finding other uses for oils and other oils for commerce. Besides coconut and lumbang, the following seeds were found to have a high oil content (Padilla and Soliven, 1933).

Bitaog (Il.), *Calophyllum inophyllum* Linn.
Balukanag (Tag.), *Chisocheton cummingianus* (C.Dc.) Harms.
Caliñgag (Tag.), *Cinnamomum mercadoi* Vid.
Madre de cacao (Sp.), *Gliricidia sepium* (Jacq.) Steud.
Para rubber, *Hevea brasiliensis* (HBK.) Muell-Arg.
Dudra (Bicol), *Hydnocarpus alcalae* (C. Dc.)
Tubang bakud (Tag.), *Jatropha curcas* Linn.
Malongay (Tag.), *Moringa oleifera* Lam.
Bulala (Tag.), *Nephelium mutabile* Blume.
Pangi (Bicol), *Pangium edule* Reinw.
Bani (Tag.), *Poñgamia pinnata* Linn.) Merr.
Mahogany, *Swietenia mahogani* Jacq.

Oils from other nuts were analyzed also. The oil of palomaria or bitaog (*Calophyllum inophyllum* Linn.) may be used for treating skin diseases. This oil and also the oil of tubang bakud (*Jatropha curcas* Linn.) are semi-drying oils only (Soliven, 1924 and 1927).

Tapping coconut palms for toddy is a common practice in this country. But the tapping was found to cause a temporary decrease in both the oil content of and available copra from the nut from these trees. This decrease however, was counterbalanced by the temporary increase in the number of nuts produced. Also it was

found that the cooking oil extracted from nuts of trees which had been tapped was better than that from nuts from untapped trees (Soliven, 1929).

INDUSTRIAL USES OF AGRICULTURAL PRODUCTS

Investigations on the possible industrial uses of Philippine agricultural products have been made. When the coconut industry was in its infancy, attention was called to the advantages of replacing the old native method of extracting oil with the expeller method (Villyar, 1917). As a contribution to the difficult task of preserving copra, it was shown that when its moisture content was less than 8 per cent, it can be kept at ordinary temperature without getting moldy (Lava, 1928). By hydrolysis and destructive distillation of the husks and leaves of the coconut, important chemicals such as furfural, phenol, wood alcohol and acetic acid were obtained (Reyes, 1933).

The present trend points to the possibility of alcohol supplementing gasoline as motive power in the Philippines. In the Islands, nipa sap and molasses are the commercial sources of alcohol. In the search for other possible commercial sources, cassava (*Manihot utilissima* Pohl.) was found to be a practical one. Indications have been obtained that poñgapong (*Amorphophallus campanullatus* Bl.) may be a good source also (Reantaso, 1934).

The necessity for manufacturing locally common household products such as pickles, sauce, etc. was recognized many years ago. In 1926, it was shown that *toyo* which compares favorably in composition, odor and flavor with the superior grade product of the market could be prepared locally (Salazar, 1926).

In view of the future Commonwealth there is a strong movement for the protection of home products. However, the people cannot be expected to patronize home products if their quality is poor compared with the foreign. This is especially true of cigars and cigarettes. To reduce the importation of these commodities, it is necessary to manufacture local brands which compare favorably with those from abroad. In 1929 it was found in this Department that tobacco leaves locally raised may be cured and then manufactured into cigarettes which approximate many American cigarettes in aroma, color and burning quality (Lava and Etorma, 1929). Several domestic brands which compete with foreign cigarettes are now found in our markets.

The yearly importation of chewing gum into the Philippines is valued at over one hundred thousand pesos. Recently, by studies

in our laboratory, it was found that latices from chico (*Achras sapota* Linn.), kalulot (*Artocarpus rubrovenia* Warb.), anubing (*Artocarpus cummingiana* Tréc.), balete (*Ficus benjamina* Linn.) and malanangka (*Parartocarpus woodii* (Merr.) may be used as chewing gum base (De Leon and Alfaro, 1934).

Derris formerly used only as fish poison is now extensively used as an insecticide. In an attempt to find out if other plants used in the Philippines as fish poisons could also be used as insecticides, lagtang (*Tinomiscium philippinense* Miers.), botong (*Barrintonia asiatica* Linn.), and malarayap (*Gardenia curranii* Merr.) were tried on nymphs and adults of *Dysdercus poecilus* H. Sch. and on *Ceratia similis* Olivier. The water extract proved toxic to the former but ineffective on the latter, thus suggesting that water extracts of these plants may be used as contact insecticides but not as stomach insecticides. The ether extract in soap solution of these plants proved fatal to both types of test insects. Lagtang is the most effective and malarayap the least (Piamonte, 1934).

FERTILIZERS

Although the use of fertilizers increases production, sometimes this increase does not offset the additional expense incurred. Way back in 1911 it was found in the Department that in the case of the coconut the use of commercial fertilizer was not profitable, and legumes and stable manure were advocated instead (Roxas, 1911).

The use of natural fertilizers such as ash and manure increased the oil content of peanuts (Silayan, 1917).

In composting farm by-products and waste, experiment showed that the pile of materials should be walled, preferably with bamboo, as this method conserves the nitrogen better than when the pile is not so protected (Sarao, 1918).

In the study of possible fertilizer fillers, banana stalk was found to be rich in potash and tobacco stems, high in nitrogen but poor in phosphoric acid and potash (Elazegui, 1929).

In studies on the growth of rice in water culture, it was found that cogon soil and soil growing bamboo contains a substance or substances injurious to the growth of rice in acid medium (Villegas, 1912).

NUTRITION

In an agricultural country like the Philippines the raising of food materials should be given first consideration. But since the health of the individual and the progress of a nation depends to a great extent on the amount and kinds of food eaten, it is very nec-

essary for the food producer to know what food people should eat and in what proportion. He should know also the food values of the crop he raises. Hence, a farmer should be interested in nutrition.

To help advance the country's agriculture, the Department has continuously engaged in the study of human nutrition problems. The trend of research has naturally fallen into two phases; namely, the study of food requirements of Filipinos and the nutritive value of Philippine food materials.

How much food does a Filipino need? In times of plenty this question need not be asked. However, under depressed conditions or "hard times" the need for an answer is at times acute. The best method of determining the answer is to examine the actual food intake of a great number of Filipinos of different ages, sexes, occupations and from different localities and then to average the results obtained from the different groups. Since this could not be done all at once, with the facilities at hand, the study had to be carried on little by little.

The students eating at the College Mess, College of Agriculture from June, 1919 to March, 1920 had the following average daily intake; proteins, 78 grams; fats, 38 grams; ash, 14 grams; and carbohydrates, 506 grams; calories, 2675 (Roxas and Collado, 1922).

In 1922 it was reported that three Los Baños families had an average daily protein intake of 70 grams and 2098 calories. The average daily calcium intake was 0.1274 gram (Roxas and Collado, 1922).

Metabolism experiments with Filipinos showed that a favorable nitrogen balance was obtained on an average daily intake of 78 grams protein and 2090 calories (Santos, 1923).

In 1928, based on the above findings, and on data obtained by others for Filipinos and also on studies made of Japanese dietary it was calculated that an average normal adult Filipino doing medium work needs 80 grams proteins, 40 grams fats and 450 grams carbohydrates daily. These give about 2500 calories a day (Santos and Adriano, 1928). Later findings confirmed this conclusion (Samia, 1930; Collado and Santos, 1933; Santos and Pidlaoan, 1933, 1934).

Food habits. The Department has taken a sympathetic rather than a critical attitude towards Filipino food habits and practices and therefore has tried to find out whether there are scientific bases for them. One such practice is the eating of *balut* (partially incubated duck egg). It has been shown that the edible portion in balut is richer in lime than the edible portion of a fresh egg (Santos and

Pidlaoan, 1931). Since the food of the Filipino is not generally rich in this essential mineral, the eating of balut is a good practice and instead of condemning it, it should be encouraged.

There is now a growing tendency for common laborers and low salaried employees working at some distance from their homes to eat at restaurants or *carihan*. It has been found that this practice is expensive. The practice of carrying kits or *binalot* is much more economical (Ylizarde, 1932; Tayao, 1933).

Nutritive value of local foods. Many Filipinos believe that foreign food materials are better than those raised locally. Many also believe that balanced meals cannot be obtained without the use of imported food materials. Both these beliefs are, of course, unfounded. It has been found that native rice, corn, meat, fish, milk, oranges and other common food materials are as rich in nutrients as the imported ones. Therefore, there is no reason for the imported food articles being preferred over those raised or produced locally.

Kandule (*Arius* spp.) is an inexpensive fish and is abundant in many Philippine waters. Partly, largely because of its eating habit, some people are prejudiced against it, although it is no worse than the pig in this respect. The flesh of kandule contains a good amount of the amino acids, arginine, histidine and lysine which are important materials for the building of muscles (Galvez and Santos, 1932).

Cassava. In the early days of the College, it was not uncommon for students who ate cassava to suffer from diarrhea and vomiting. Usually this was due to the prussic acid in the cassava. This poison is soluble in water. So before eating cassava to make it safe it must be thoroughly boiled in water. It was known that different varieties of cassava vary in content of this poison. The value of cassava as a food and this risk or possible danger in eating it aroused investigating interest and samples of different varieties of cassava were brought to the Department by members of faculty and advanced students for determination of the amount of prussic acid. The following varieties were found to be low in this poison; Aipin Valenca, Aipin Mangi, Mandioca Basiorao (new), Aipin Manteiga. But the common Mandioca Basiorao was found to be high in it.

Gallan or palauan (*Cyrtosperma merkusii* (Hassk.) Schott) is a tuberous plant that grows in swampy places and in soils that are constantly moist and useless for producing important agricultural crops. It can be grown easily as it needs no special care. A number of food preparations are made from gallan, such as jam, bibingka (hot cake), minokmok (powdered boiled gallan, mixed with grated coconut and sugar), suman (finely grated gallan mixed with sugar and grated co-

Fig. 2.—Palauan, a food plant that may be used as substitute for rice. An entire plant, showing a very young tuber at the surface of the soil, and two flowers.

conut—wrapped with banana leaves and boiled), palitao or bilobilo (boiled dumpling), and maduya (fritter). It is sometimes used in place of sweet potato tubers in a Spanish viand called *puchero*. In time of food shortage it may be used as a substitute for rice.

Gallan has been found to be a good source of carbohydrates, and when used as the only source of this nutrient it also furnishes sufficient water soluble growth promoting vitamin (for albino rats). The young leaves and inflorescence may be eaten as a vegetable and both are rich in the growth promoting vitamin (Gesmundo, 1932).

The Latundan is the most popular banana in the Philippines. When compared with the other common varieties, it was found to be the easiest to digest (Santos, et al., 1933).

There is a general belief that the Saba banana when uncooked is hard to digest. Studies showed that when Saba is fully ripe it is easier to digest when raw than when cooked (Canlas, 1932).

Seaweeds serve as a vegetable and are eaten in large quantities especially by those who are living along the sea coast. They are good source of the mineral, iodine. However, when young animals (rats) were given an abundance of seaweeds (70 per cent of the diet) growth was retarded (Collado, 1926).

Beriberi is a disease which in spite of the campaign against it in the past years still afflicts a large number of people in the Islands. The prevalance of this disease indicates that the food of not a few people is deficient in the anti-beriberi vitamin. The disease is usually associated with the too exclusive use of polished rice. During the process of polishing, the bran which contains the vitamin is removed. So the eating of unpolished rice is advocated. However, not all unpolished rice is preventive of beriberi. Unpolished Gariñgan Tapucoy rice is poor in anti-beriberi vitamin. In Mindoro, many people who were accustomed to eat Gariñgan Tapucoy contracted a disease called *lapnus* (Santos and Collado, 1932).

Foreign workers have shown that the anti-beriberi vitamin is found to be abundant not only in unpolished rice, but in some other food materials as in vegetables and fruits. A goodly number of our fruits and vegetables have been examined in our laboratory and it was found that in general they are good sources of this vitamin. Of the vegetables, sweet potato leaves and shoots appear to be the richest in anti-beriberi vitamin. Sprouted mungo or *togi* and the young leaves and flower of squash are also good sources of this vitamin (Santos, 1922; Acuña, 1923; Santos and Santos, 1926; De Jesus, 1927; Santos and Collado, 1928; Rotor, 1928; D. Santos, 1932; Gopez, 1932).

Of the fruits, *avocado* is one of the richest in anti-beriberi vitamin (Santos, 1922). Since tomato is rich not only in anti-beriberi but also in anti-scorbutic vitamin, the increased use of it is advised. At least one raw tomato a day should be consumed. The popular and expensive fruit the lanzon (*Lansium domesticum* J.) was found to be poor in anti-beriberi vitamin (Villanueva, 1932).

Since fruits and vegetables are good sources of vitamins and minerals, people are advised to get these nutrients from the market or better still from their gardens and not from the drug stores.

The following summary compiled by the Reference Librarian in the Scientific Library Department of Agriculture and Commerce shows the number of contributions and their source that have enriched the scientific world through *The Philippine Journal of Science* from its first issue in January, 1906 and including April, 1934. This valuable journal is published by the Philippine Bureau of Science.

Bureau of Science Staff	981
Bureau of Agriculture	37
(Divided into Bureau, of Plant Industry and Animal Industry, 1929)	
Bureau of Animal Industry	3
Bureau of Civil Service	1
Bureau of Education	16
Bureau of Forestry	14
Bureau of Plant Industry	2
Weather Bureau	6
Bureau of Health	86
Rockefeller Foundation	22
U. S. Army Medical Research Board	55
U. S. Army and Navy Officers	19
College of Agriculture	92
College of Engineering	1
College of Liberal Arts	88
College of Medicine and School of Hygiene	193
School of Pharmacy	3
College of Veterinary Medicine	16
Department of Agriculture and Commerce	1
Division of Fish and Game	3
Department of Interior	8
Philippine General Hospital	11
Philippine Library	1
Local Contributors	36
Foreign Contributions:	
Based on materials from Bureau of Science	134
Based on materials from College of Agriculture	199
Based on materials from College of Liberal Arts	1
Metropolitan Water District	1

THE DIVISION OF SUGAR TECHNOLOGY IN THE SERVICE OF THE PHILIPPINE SUGAR INDUSTRY[1]

GETULIO A. GUANZON
Of the Department of Agricultural Chemistry

The following are some of the contributions of the Division of Sugar Technology in the establishment of the Philippine sugar industry on a more scientific basis:

SUGAR AGRONOMY

Maturity tests of cane varieties. One of the most difficult questions that confronts a sugar cane planter is when to cut his cane in order for him to obtain the highest returns from his field. The sugar yield for a unit area of land is dependent primarily on two factors; the percentage of sugar and the weight of the cane. Since the sugar content in the cane increases during ripening and decreases afterwards, the advisability of harvesting at the time when the maximum quantity of sugar has been formed is apparent. The problem of harvesting is made more complicated by the fact that the rate of ripening varies with different varieties, locality, climatic conditions and manner of cultivation and fertilization. Experiments conducted under Laguna conditions show that Cebu Purple matures and may be harvested at the age of twelve months, N. G. 24-A at about nine months, Hawaii 109 at twelve months, Chinois at fourteen months, C.A.C. 87 at fifteen months, and B-147 at nine months. In determining these ages, analyses of field samples of the different varieties were made in the Division at three weeks intervals for three months. It was also shown that harvesting the canes a month earlier than maturity might mean a loss of from 50 to 320 pesos per hectare, depending on the variety (Villa, 1928).

With the introduction of the hand refractometer in the Philippines in 1928, it was believed that the planter could determine the sugar in his cane before harvesting. Many of these instruments were sold to planters on the strength of this belief. Results of investigation conducted by the Division indicated that there is no definite criterion which will enable a planter to definitely judge the maturity of cane. The fact that there is a period when the refractom-

[1] General contribution from the College of Agriculture No. 413.

eter solid content at the topmost joint of the millable cane nearly equals that of the last portion of such may aid in determining the maturity. It was also shown that as possible maturity is approached the glucose content becomes a minimum and the sucrose content a maximum even though the refractometer solid content may show no variation (King, 1930).

Studies on the root and shoot development of Mauritius Seedling, 1900. It was found that shoot development increases correspondingly with increase in root development. Ammonium sulfate increases the root masses not only in the sections near where the fertilizer was applied, but also in the whole root system. The suggested method as determined by experiment in the Division is to apply fertilizer by placing it in the cane furrow, just before setting the point, in an oval with longest diameter about six inches (15.2 cm.). The fertilizer should be mixed with the soil, and water poured over it to carry it down to the lower levels. Then the point should be planted over the spot where the fertilizer was applied (Roxas and Villano, 1929).

Germination tests of cane varieties. Poor germination of planting materials is an influential factor in producing low tonnage of cane, a fact recognized by cane planters everywhere. The problem of testing the germinating power of the different commercial cane varieties in the Philippines is, therefore, of paramount importance. Results of experiments conducted by the Division at Hacienda Carmencita, Pampanga, showed that Cheribon and Cebu Purple gave poorer germination than Mauritius Seedling 1900, Hawaii 109, or Badila and were very susceptible to mosaic (Grecia, 1926). Germination studies on POJ 2878 sugar cane points showed that soaking for twelve or twenty-four hours in lime magnesia sulfate solution, or twelve hours in water at pH 6 to 7 gives an early and a higher percentage of germination than other treatments (Bantug, 1934).

Methods of treating ratoons. The success of a sugar cane planter is to a large extent determined by his ability to grow a good stubble crop. Instead of burning the field trash after harvesting the plant cane as is commonly practiced in the Philippines, Earle in Cuba advocated the system of piling the trash in alternate rows, thus solving the troublesome question of a proper and economical disposition of the trash without burning it. In an experiment carried at Del Carmen, Pampanga under the direction of the Division, it was indicated that the Earle method gave slightly higher tonnage of cane, higher juice purity and higher yields of sugar per hectare than the ordinary

method of treating ratoons by burning the trash. The Earle treatment produces larger canes and is much less expensive to undertake than the ordinary treatment (Montinola, 1927).

The effect of mosaic disease on cane weight and sugar yield at maturity. Many investigations have been published on the nature and cause of the mosaic disease, but only a few have been carried out on its effect on yields of cane and sugar from the different varieties grown commercially. Data in the Philippines are especially lacking, so that studies along this line of work were of particular interest to Philippine sugar cane planters. It was shown that mosaic infected Mauritius Seedling 1900 may lose 65 per cent of the weight of cane and 69 per cent of the sugar obtainable from healthy canes. Of the native canes, Luzon White and Pampanga Purple were the varieties most seriously affected, losing per hectare 58 and 51 per cent of cane weight and 62 and 56 per cent, respectively of sugar yield obtainable from the healthy canes. Cebu Purple, the least affected among the native canes, lost 42 per cent in weight of cane, and 44 per cent in sugar yield per hectare. Of the other foreign varieties tested, Barbados 147, Hawaii 109 and N. G. 24-A showed, respectively 66, 51 and 35 per cent loss in weight of cane and 65, 49 and 21 per cent loss in sugar yield per hectare (Luzuriaga, 1929).

Potash and phosphoric acid content of cane juice. Potash and phosphoric acid are two of the three most essential elements for sugar cane growth, the presence of the latter is also important in the subsequent clarification of the juice in the process of sugar manufacture. Work under the Division on the potash and phosphoric acid content of juices from different varieties of cane grown in the same field showed that assimilation of these two elements is a varietal characteristic of sugar cane. A variety such as Hind's Special, for example, may contain as much as 2.5 times the phosphoric acid content and 2.7 times the potash content of another variety, such as Badila or Java 247 (Eubanas, 1928).

SUGAR MANUFACTURE AND CHEMICAL CONTROL

Capacity of milling trains. In calculating the capacity of milling trains results are more accurate if capacity is expressed in tons fiber per hour or per day instead of in tons cane per hour or per day. The modified Walker equation gives higher capacities which agree fairly well with average tons of cane ground under Philippine conditions (Ebro, 1932).

Mill sanitation. It was found by tests that cleanliness in the milling plant is essential in order to reduce considerable destruction

of sucrose by deterioration and acidity increase of the mill juices. Increase in acidity from the crusher to first mill, however, is not due to bacterial action as the time of extraction is less than one-half minute, but is due to the expression of organic acids from the canes by heavy pressure in the first mill (King and Gomez, 1931). Reasonable sanitation through the use of hot water at 3-hour intervals together with a periodic removal of accumulations of bagasse and sediment and the use of deep sloping pans and trough will reduce mill juice decomposition to a minimum (King, 1930). It was found that the use of chemicals and lime water is not advisable for cleaning the mills owing to the increase in actual acidity of the juice over the theoretical total acidity of the normal juice (King and Gomez, 1931).

Sugar cane colloids and clarification. Sugar cane colloids are composed of various substances, organic and inorganic in nature. These are extracted by the mills and are dispersed in the juice in various sizes larger than molecular but too small and too light to go down as settlings. When not removed in the process of clarification the colloids promote increase in viscosity of the liquor resulting in slower boiling and evaporation of the juice and syrup. It prevents higher recovery of sugar from solution and is also mainly responsible for the production of poor quality sugar which absorbs moisture readily and deteriorates faster than when produced from better clarified liquor. Experiments conducted by the Division indicate that the amount of colloids present in the mill juices is a function of the quality of cane ground. Using the usual lime defecation process the percentage of colloid elimination in one Philippine central ranges from 10 to 32 with an average of 15.6 per cent (Monsalud, 1931). It was also shown that heating before and after liming indicate no advantage in either method from the standpoint of increase or removal of non-sugars. It has been claimed that more silica is removed by heating to 120°C. before liming; no such evidence was observed. The only advantage was less lime scale formation in the heater, but this advantage was to a large extent offset by an increase in reducing sugars which aided in producing a very dark colored juice in cases where the raw juice of pH below 5 was so treated (King, 1931).

It was shown by another experiment, that marked increase in viscosity of syrup and low grade liquors is observed from mixed juice limed to pH 8.4 or above while gum content increases from pH 6 to 7, decreases from pH 7 to 9.5 and increases again from pH 9.5 and above (Flores and Batenga, 1934). Magnesium elimination

in the clarified juice increases with increasing pH of the cold lime juice (Batenga and Flores, 1934). Greater elimination of solid non-sugars in the last mill juice is accomplished by liming to pH 10 or above. Good clarification can be obtained by heating at 90°C. A comparable improvement in clarification can be obtained by combination of last mill juice with mud coming from the settling tanks, liming this to pH 10 and resettling and then using the resettled juice for tempering the mixed juice (King and Villareal, 1933).

Tempering the juice by the application of heat and lime is the method most widely used in raw sugar manufacture. There are, however, various modifications, some of which, are rather complex, others more simple, depending on the differing conditions of different centrals. The Ventura system of compound clarification is being tried by the Pampanga Sugar Devolepment Company at San Fernando, Pampanga. It is claimed for this method, that by its use, juices from immature canes, which are difficult to clarify by the usual method may be clarified satisfactorily. The method works on the fractional precipitation plan, that is, the lime is applied in two doses; the first in the cold to pH of 6.1 to 6.4 and the second in the hot to a pH of 7.4 to 7.8. Unlike other modifications, the Ventura method does not entail additional cost in material and equipment. As the Ventura method is a new process, it is to be expected that it has some objectionable points which may be remedied or corrected by further investigation. Data obtained by studies conducted in the Division indicated that the Ventura system gives better refining quality of sugar than the common method, and gives no heavy inversion losses as compared with the hot liming method (Sitchon, 1931).

The determination of the turbidity of the clarified juice is a part of the routine work in the chemical control of a raw sugar factory. Increasing attention has been directed during recent years to this particular phase of sugar manufacture in order to improve the refining quality of the raw sugar produced. No exact data were available on whether or not the information derived from such determination will aid in the improvement of the refining qualities of the sugar produced. From the results obtained from the work it was indicated that the measurement of turbidity is of little value unless all of the various factors entering into the formation of the turbidities are known and can be given due consideration. These factors are size of suspensions and color of the solutions. Hence, a careful consideration of data obtained and the fact that the character of the suspensions present in any sugar governs the filtration

rate or the refining characteristics of a raw sugar suggests the abandonment of determinations of turbidity where quantitative results are desired (King, 1929).

Color perception of sugar laboratory workers. The accuracy of any colorimetric determination is always subject to speculation on account of the personal equation. A director of research, a sugar technologist, a factory superintendent, or a soil technician must depend upon quick methods for the control or estimation of reaction and percentage composition of samples. Experience has shown that colorimetric determinations are highly adaptable but no in-

The U. P. Sugar Mill as it looks today. The structure is a result of the latest improvement made in 1933 by the installation of a new 50 H. P. boiler and the erection of concrete posts to support the upper structure of the building. The first mill erected about 15 years ago was on bamboo posts and the boiling house equipment consisted of materials made from empty kerosene cans.

formation in the literature is available that would aid in establishing the error of such colorimetric determination or the ability of laboratory workers to differentiate or match delicate color hues. In order to obtain direct information an investigation was conducted by the Division which would differentiate the ability of laboratory workers into two groups. These two groups were composed of those individuals who could distinguish colors by name and those who could distinguish colors by comparison with a given standard. As a result of this investigation, it was concluded that for students who plan to

enter the field of chemistry or sugar technology more care should be given in training them to become familiar with color determination. Modern requirements demand that the color blind individual be directed to other fields of endeavor. The results of this study will aid in determining the accuracy of individual workers and will provide a simple method of evaluating workers assigned to colorimetric work (King and Guanzon, 1929).

Methods of sugar boiling and crystallization in motion. A common practice in cane sugar factories is to heat the molasses preliminary to injection into the pan. The object is to reduce viscosity and dissolve minute crystals which may impair the quality of the resulting massecuite. In the investigation conducted by the Division, it was found that the practice of pre-heating large quantities of "A" molasses prior to boiling in the pan should be curtailed as much as possible, as it results in considerable losses of sucrose by inversion (King and Jison, 1933). Also considerable losses of sugar in crystallizers during cooling occurs where the temperature at discharge is high and the massecuite maintained at a high temperature during the preliminary period of cooling. The sucrose losses are also a function of the purity of the massecuite discharged (King and Jamora, 1930). It was also found that losses of from 1 to 2 per cent sucrose per 100 solids may occur within 30 to 50 hours after the massecuite is dropped into the crystallizers, and massecuite held in the crystallizers for 75 to 90 hours may have sucrose loss of from 0.12 to 0.45 per cent. In general, time and temperature have direct influence upon sucrose loss (Gomeri, 1931).

An experiment carried on recovery of sucrose from final molasses indicated that this is possible by replacing the basic salts of sodium and potassium in the molasses complex with calcium or magnesium (King and Oliveros, 1933). About 1928, a Philippine sugar factory adopted the Lafeuille crystallizer pan, a new invention which performs the functions of both the vertical pan and ordinary U-type crystallizer. It was believed that this new equipment not only saves labor and increases pan capacity by shortening the time of handling low grades, but that it actually produces final molasses of greater degree of exhaustion than that obtainable by use of the ordinary crystallizer. On the strength of this belief, other centrals have adopted the equipment. Results of comparative studies recently conducted by the Division, however, indicated that Lafeuille's claim to higher recovery of sucrose as shown by comparative purity figures is not well founded. On the contrary, destruction of sucrose in the crystallizer pan seems to be greater than that observed by use

of the vertical pan and ordinary U-type crystallizer (Guanzon and Fernandez, 1934).

Viscosity in relation to low grade sugar house products. Viscosity is the resistance offered by the liquid to the relative motion of its particles. It was found that the presence of sugar crystals in the molasses increases the viscosity of the solution. The greater the percentage of crystals in the mixture, the higher the viscosity. These findings may explain the probability of an economic limit, especially for low grade work, at which crystal yield must be allowed to proceed. Viscosity also increases with increasing gum content. It also appears from this study that the larger the grains present in a massecuite the higher the viscosity (Sason and Ebreo, 1931; Pee, 1932; and Veloso, 1933).

Distribution of sugar. In Philippine sugar centrals a large number of planters send in cane every day of the milling season, and to these planters the proper quota of sugar should be distributed. There are several methods of sugar distribution followed in Philippine centrals. Of these, three were selected and compared in the Division. It was found that Walker's method is the most logical in that it takes into account the fact that high purity juices give molasses of lower gravity purity than low purity juices, and should, therefore, be given proportionately more sugar than the latter. Walker's method, therefore discourages the sending in of poor cane which will produce low purity juices, and thus may lead to efforts on the part of the planters to send in good quality canes (Hollero, 1927).

Composition of Philippine raw sugars. For several years past New York refiners have complained of the poor refining qualities of Philippine sugars. To improve the refining quality of Philippine sugar, Walker, some years ago recommended the production of raw sugar of 96.8 to 97.20 polarization, and with low percentages of ash, gums and moisture. Analysis conducted in the Division indicated that Philippine raw sugar has poor refining quality as shown by its relatively high gum and moisture content (Suerte, 1928).

Philippine molasses. Accurate data concerning the constituents of Philippine molasses are rare. Information concerning the variation in the different constituents was desired in order to obtain a possible correlation between the viscosity and the purity of representative Philippine molasses. Information was also desired concerning the character of the non-sugars as influenced by various soil and climatic conditions. The results of analysis conducted in the Division show that Philippine molasses is high in sodium oxide

and silica content, low in sulfate and high in chloride content. The presence of high calcium content is accompanied by the high colloid content as shown by the dye value (Rotor, 1933).

Other experiments conducted in the Division on final molasses show that sucrose by invertase hydrolysis is higher than sucrose obtained by acid hydrolysis. From this study it is believed that for the determination of sucrose in raw and refined sugars acid hydrolysis is satisfactory but for low grade sugar house products the invertase method should be preferred (Bermejo and King, 1929).

It was also shown that the amount of dry lead subacetate used is not an index of the degree of clarification of final cane molasses for the determination of sugar by means of the polarimeter. Increasing the amount of lead used results in higher figure for the apparent purity and correspondingly lower gravity purity of the molasses (Fernandez, 1932).

BY-PRODUCTS OF THE SUGAR FACTORY

Final molasses. With the use of motor alcohol for fuel in gas engines, interest in the utilization of final cane molasses has increased tremendously, resulting in the recent construction of distilleries in many centrals. Data on the best available methods of obtaining the maximum alcohol yield from a unit quantity of sugar in Philippine molasses is, however, lacking. The Division recently undertook studies on the possibility of getting the maximum amount of alcohol yield from molasses by use of catalysts which are obtainable locally. It was shown that the leaves of *Macaranga tanarius* Linn.) Muell.-Arg., locally known as binuñga or samac, is an excellent catalyst for the optimum production of alcohol from final cane molasses. Samac grows wild in many part of the Philippines, and in the northern provinces it is extensively used by native manufacturers of basi to impart flavor to the product (Guanzon and Flor Cruz, 1934).

Final cane molasses may also be utilized as a commercial source of vinegar. The nutritional value of molasses vinegar is higher than that in vinegar obtained from other sources owing to the presence of high lime content which is needed by the body (Guanzon and Marfori, 1934).

Filter press cake. Work undertaken on the possible uses of filter press cake from cane sugar factories show that this can be utilized as a commercial source of cane wax which has been proved to be a good substitute for carnauba wax. This wax is extensively

used as raw material for the manufacture of shoe polishes, Christmas candles, tailor chalks, and special kinds of varnishes. The yield of crude cane wax is about 4.5 per cent in air dried press cake, and the cost is about 60 per cent lower than the cost of carnauba wax (Guanzon, 1925).

Sugar cane bagasse and decolorizing carbons. The experimental stage in the preparation of vegetable decolorizing carbons is said to have reached its peak. However, methods developed along this line have always been kept secret so that only in those countries where the methods are utilized commercially are the benefits derived from their use. The Philippines has an abundant supply of woods and by-products from the various industries as the sugar, rice and lumber that can be converted into active carbons which may be used for decolorization in the manufacture of white sugar or other industrial commodities such as chemical, pharmaceutical or certain food products which need purification. At present the two sugar refineries in the Philippines use imported carbons. Hence, the production of vegetable decolorizing carbons locally would greatly help the rice, lumber and sugar refining industries. Among the materials tested, bagasse was found to be an excellent source of decolorizing carbons. Other materials that may be used as good sources of decolorizing carbons are pili nut, cork, coconut husk and box shavings while the best activator found is zinc chloride, followed by sodium hydroxide, hydrochloric acid, chlorine gas, aluminum chloride, and ferric chloride in the order named (Abes, 1932). It was also found after working with about 17 possible activators that zinc and ferric chlorides are the most suitable for producing active carbons from white lauan, malabulo and malabulak woods (Rivera, 1932).

OTHER INDUSTRIES

The kinds of problems met with in sugar technology are not confined to the sugar industry alone, but they are also found in other industries in which sugar technologists may be interested. For this reason, the Division has from time to time gone beyond its boundary to help solve problems which have confronted some industries at one time or another.

The College Copra Drier. For several years there was felt a persistent demand for a copra drier which could be used by the small planters. Several copra driers had been invented in the Philippines, but some of these were expensive to maintain and none fully complied with what was demanded in a drier particularly suited for the small coconut planters. The answer to the cry from these plant-

ers came from the Division of Sugar Technology, when in 1926, the New College Copra Drier was created. It was found after several competent tests to fulfill the following conditions: (1) simple of construction and made of easily obtainable materials; (2) fitted with an easily adjusted temperature device; (3) could be made at moderate cost; (4) the cost of running it is not higher than that of the ordinary tapahan; (5) uses only the husks and 60 per cent of the shells, so that part of the shells may be sold as a by-product (Roxas and Henares, 1926).

Utilization of fibers from coconut husk. At about the same time that the copra drier was invented, a simple machine which can be profitably used for extracting fibers from coconut husk was tested in the U. P. Sugar Mill. The coconut husk fibers may be used for making door mats and cushions of all kinds (Henares, 1926).

Commercial utilization of toddy. In many provinces where the coconut palm is grown, the practice of tapping the flower for toddy or coconut sap is commonly followed. This toddy is a common beverage of the masses in coconut regions, and is the most popular medium of friendly exchanges of good cheer at social gatherings of the older generation in small town festivals. Experiments that are being conducted by the Division on the clarification and preservation of toddy, indicate that its use could be extended, that a delicious table syrup rivaling honey in flavor and quality could be prepared commercially for domestic consumption or for exportation. Also the clarified and preserved toddy could be bottled directly and sold as a light beverage like lemonade, with or without compounding (Guanzon, 1934).

White sugar from nipa sap. In the summer of 1925, the staff of the Division of Sugar Technology conducted an experiment on the possibility of making white sugar direct from nipa sap. The work was done at Kwala Semauang, British North Borneo and financed by the Nipah Palm Products Company of British North Borneo and Manila. It was shown that white sugar can be manufactured from nipa sap at a comfortable margin of profit if the labor cost of collecting the sap could be cut down to the minimum existing in the Philippines (Roxas, Henares and Guanzon, 1925).

The total land area of the College of Agriculture covers 397.1619 hectares.

PALM DRIVE

The main road of the Campus, leading from the Gate through the grounds to the School of Forestry and Mount Maquiling National Park.

AGRICULTURAL ENGINEERING INVESTIGATIONS IN THE PAST TWENTY-FIVE YEARS [1]

A. L. TEODORO
Of the Department of Agricultural Engineering

The constructing of a machine which would extract cassava starch was the first outstanding investigation carried out in the Department of Agricultural Engineering. A device made principally of Philippine woods was constructed, tested, and found efficient (Cuzner, 1917). It was run by a 2-1/2 horsepower engine. Another home-made apparatus for determining the tensile strength of grain stem was also constructed (Cuzner, 1918). Its value was never realized, however, as the device was not perfected. Undoubtedly more home-made devices would have been designed and constructed had not the men in charge of the Department from 1909 to 1918 been given the whole supervision of the construction of all of the buildings then being erected in the College. In that period only two original investigations by the thesis students in the Department may be considered important. One was the transverse strength of structural bamboo (Santos, 1917), and the other the effect of curing on the strength of bamboo (Teodoro, 1918). In these studies the thorny bamboo was found to be definitely stronger than the thornless bamboo. They both exhibited perfect elasticity curves up to a certain limit. The deflection of the thorny bamboo averaged less than the thornless bamboo. Curing the poles for thirty days under the sun gave nearly the same effect as curing for sixty days in shade. Cracks were evident in many poles that were exposed under direct sunlight for over sixty days. A summary of the results of the second subject was published in 1925 in the *Agricultural Engineering Journal* of the American Society of Agricultural Engineers.

From 1919 to 1929, extensive studies were confined to survey work on irrigation and drainage practices, on comparing costs of operation between mechanical and animal power, on drafts of plows, and on cement and concrete (Gordon, 1929; Sonza, 1929). Nine separate investigations on irrigation carried out in three different irrigation districts within four years definitely pointed out that there were two periods in which water was needed for irrigation of rice

[1] General contribution from the College of Agriculture No. 414.

(Gordon and students, 1929; Teodoro and Bataclan, 1931). The first period, comprising land preparation, required a constant supply of water for soaking and for puddling the fields for a period varying from 38 to 50 days. The greatest amount of water was used when the fields were being puddled before they became set. Approximately, 20 centimeter-hectare was needed in the second and in the third harrowings. The water was most needed during the period of intermittent irrigations in which approximately 15 centimeter-hectare was constantly needed for more than a month. The total number of days in which the plants were kept submerged intermittently from the time of the first application of water until

Fig. 1.—Laboratory practice in farm machinery. Students operating a small rice thresher at College Tool Room.

it was removed to permit harvest, varied from 55 to 65 days. The average length of the growing season from transplanting to harvesting was about 115 days.

Three studies were made on the actual cost of operation between mechanical and animal power (Africa, 1920; Lopez, 1923; and Castro, 1924). Very limited data were obtained, however, and no definite conclusion could be drawn.

Seven investigations on the drafts of plows were made (Teodoro, 1925; Sindhuravejna, 1925; Carreon, 1925; Feliciano, 1925). In these studies relations were established between animal power and drafts of native plows, Philippine-made walking plows, and different types of foreign-made single-animal walking plows. The Vargas

plow and Salas plow were included in the studies. The mechanical requirements, quality of plowing, and advantages and disadvantages of various plows under adverse soil and weather conditions were determined.

How a bean thresher may be converted into a small rice threshing machine was worked out by a thesis student (Bondoc, 1929). With the use of only a 1–1/2 h.p. engine as a source of power this simple rice thresher was successfully operated. New parts were constructed in the blacksmith shop of the Agricultural Engineering Department to meet the specific needs of a fairly efficient rice-threshing machine.

A very practical way of utilizing waste was demonstrated when a member of the staff built simple, clean, and very efficient charcoal stoves from broken flower pots (Teodoro, 1923). A thesis student experimented on bamboo as a drain tile and found it satisfactory (Mamisao, 1931).

From 1929 to date, the research work in the Department has been centered on the suitability and adaptability of alcohol as fuel for all kinds of internal-combustion engines (Teodoro, 1931–1932–1933–1934; Teodoro, Cruz, Bautista, 1933; Cruz and Ang, 1932). In response to the suggestion of the Director of the College of Agriculture Experiment Station, an extensive series of tests were carried out on this subject in coöperation with sugar centrals, petroleum and oil companies, and internal-combustion engine manufacturers. The most important points considered were fuel and oil economy, general engine operation, power, and engine wear. Both bench and road experiments were performed to cover field and laboratory conditions.

The results of these tests led to the manufacture of a commercial fuel, consisting of nearly straight alcohol, the demand for which at present more than exceeds the supply. Two big transportation companies are reaping increased profits by using this fuel in their buses instead of gasoline.

The attitude towards the results of these experiments by those interested was expressed in letters received by the Director of the College of Agriculture Experiment Station and by the Department of Agricultural Engineering. Acknowledgments were made of the incalculable value of this research work and of the far-reaching benefits to be derived from what had been accomplished not only by the sugar industry but also by the public at large.

The results of the extensive tests in these investigations point to the fact that the use of nearly straight alcohol in the Philippines

appears now to be definitely a commercial possibility. At the present selling price of alcohol at ₱0.05 per liter and of gasoline at ₱0.12, it is possible to save nearly ₱10 per thousand kilometers of travel by the use of alcohol instead of gasoline.

The most significant results were:

1. There was a definite decrease in alcohol fuel consumption as the compression ratio was increased.

2. Alcohol-gasoline combination showed a decrease of fuel consumption as the percentage of gasoline was increased.

3. Pre-heating caused a slight economy of fuel as the load decreased from three-fourths of the normal capacity of the engine.

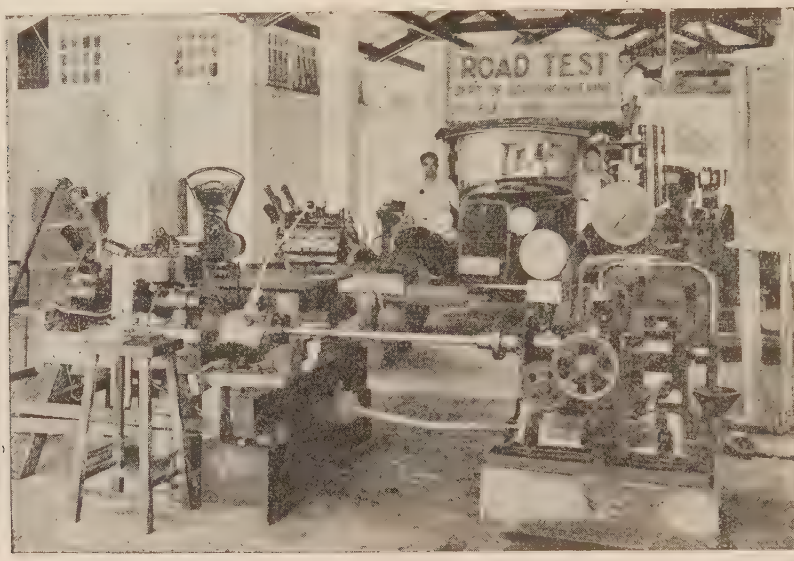


Fig. 2.—Comparing Philippine motor fuels with the imported. The performance of automobile and truck fuels is being compared, using both the modern dynamometer shown at the right, and extensive road tests with cars and trucks.

4. The maximum power developed at equal compression ratio was slightly higher for alcohol than for either gasoline or kerosene because of the high latent heat of alcohol.

5. Crank case oil dilution was less in alcohol fuels than in hydrocarbon.

6. Operation with alcohol fuels was characterized by the absence of fuel knock, clean combustion chamber and spark plugs, and slightly delayed starting on cold damp mornings.

Besides these fuel tests and studies, during the last five years investigation on the cost of operation using modern farm imple-

ments has been started (Catambay and students, 1933). Further studies on drafts of plows (Sibal, 1934) and on cement and concrete (Caguicla, 1931 and Bautista, 1933) have been made but not completed. Preliminary investigation on weir measurements and on venturi flumes have also been begun (Bautista, 1933).

The results of the investigational and research studies in the Department of Agricultural Engineering during the past twenty-five years may be considered to have attained the following major objectives:

1. Producing home-made mechanical devices that proved efficient and economical in meeting specific needs.

2. Gathering of facts on many subjects with specific application in view and for the sake of the knowledge itself.

3. Applying results of research studies to industrial development.

Mean temperature and rainfall at the College of Agriculture (1916–1933).

	Temperature °C.	*Rainfall mm.*		*Temperature °C.*	*Rainfall mm.*
January	24.6	67.5	July	27.1	339.5
February	25.5	29.1	August	28.7	.276.9
March	26.8	28.8	September	27.1	253.7
April	28.3	36.2	October	26.9	249.3
May	28.5	143.3	November	26.2	269.0
June	27.8	209.7	December	25.5	129.7

The Maquiling National Park covers an area of 3,787.5323 hectares. It contains approximately 2,500 species of plants and is better known faunistically than any other place in the Philippines, especially in connection with its insect life.

Wireless is credited with having added approximately 5,000 words to the English language.—*The New Zealand Dairyman.*

THE ACCOMPLISHMENTS OF THE DEPARTMENT OF AGRICULTURAL EDUCATION [1]

FRANCISCO M. SACAY
Of the Department of Agricultural Education

In the field of resident instruction, the Department of Agricultural Education has turned out 22 trained teachers of agriculture. They are now employed as teachers of agriculture in different agricultural schools under the Bureau of Education. One graduate is now acting as division industrial supervisor. Besides these holders of Certificates in Agricultural Education a large number of students has taken one or more courses offered in the Department. This latter group was instructed in the importance of vocational education, particularly vocational education in agriculture. They were taught how to discover the needs and problems of rural life as well as the educational agencies and processes which may be employed in its improvement. The elevation of the standard of living and standard of life in the country can be brought about only through intelligent rural leadership. Certain courses offered in the Department prepare the student for this leadership. The students develop a favorable attitude toward rural welfare, a high ideal concerning rural life, and learn ways of discovering rural needs and methods of bringing about improvement.

The Rural High School, a subsidiary unit of the Department, has turned out 80 graduates. These graduates are either farming or pursuing higher education, principally in the field of agriculture. A number of the graduates have taken up homesteads in Mindanao. Many other students studied in the Rural High School but did not graduate. These students are either engaged in farming or are pursuing studies in various fields.

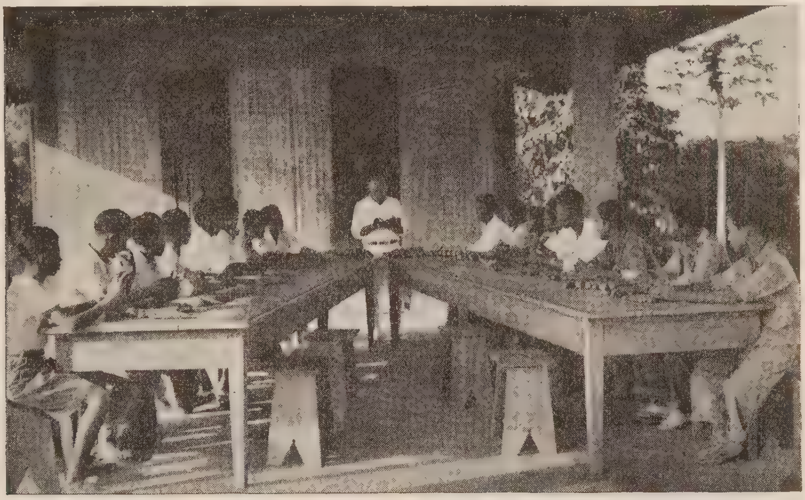
In the field of research in agricultural education, the Department has made just a beginning. The first four years following the establishment of the Department in 1928 were devoted primarily to organization. It was in 1933 that the first study was published. Two research studies have been published and several are in progress.

In the first study the investigator attempted to discover the characteristics of the student population in agricultural schools. To

[1] General contribution from the College of Agriculture No. 415.

properly conduct the educational process it is necessary to know the pupils, or individuals to be educated. Among the factors studied were: the patronage area of agricultural schools, the age of pupils, their social background, the size of home farms, the elimination and persistence of pupils in agricultural schools, and the occupational intention of pupils. The bearing of these factors on the organization and administration of vocational education in agriculture was indicated.

In the second study an attempt was made to discover the fitness of the teachers of agriculture for their job. Some of the factors considered were: age, educational attainment, occupational background, farm experience, professional training, civil service eligibility, years of teaching experience, number of subjects taught, and relation of specialization to teaching position held. Ways and means of training teachers in service were also discussed.



In the Laboratory Shed in the farm crops field Rural High School students are given practical instruction in selecting seed corn, an important principle of producing better crops.

In addition to the foregoing studies, several articles in the field of agricultural education have been published by members of the staff. These include such topics as the place of agricultural education in our agricultural readjustment, a general outline of a program of agricultural education, the place of research and education in the future of Philippine agriculture, tendencies in the choice of high school courses, rural life and rural improvement, analysis of the problems and needs of rural life, the importance of poultry raising

in schools, poultry raising in the University Rural High School, agricultural education among Negroes in Southern United States.

The research projects in progress at the present time deal with the evaluation of content of agricultural subjects in the curriculum, effectiveness of instruction in agricultural schools, and survey and analysis of educational needs of rural communities.

In the Philippines, the importance of teaching agriculture is gradually being recognized. Agriculture has already been introduced in many academic high schools. Much interest has also been shown in the education of the adult farm population. The creation of the Rural Improvement Committee and the appearance of the community assembly are proofs of this interest. To carry out effectively a program of rural education and improvement requires trained agricultural teachers, extension workers and rural leaders. The Department of Agricultural Education will have to meet an increasing need for trained personnel in the agricultural teaching service in the future.

Science is international. Science at its best is also a fraternity. As in other fields of endeavor, we must recognize that in reaching for our objectives we stand on the shoulders of our predecessors and companions.—R. R. WILLIAMS.

The altitude of the highest peak of Mount Maquiling is 1,100 meters. The altitude of the dipterocarps on Mount Maquiling is approximately 600 meters. The beginning of the mossy forest is at an altitude of 875 meters, approximately.

In the rain-forest from 600 meters altitude to the summit, oaks and other characteristic alpine forms abound.

Success means nothing more or less than doing the work you are suited for to the best of your ability. It means getting fitted into your proper place in life's machinery, doing each day's work honestly, living cleanly and thriftily, and trying each day to improve upon the work of the day before.—*The Kalends of the Waverly Press.*

THE LOWER CAMPUS AND COCONUT GROVE

With Laguna de Bay in the background

SOME PRACTICAL CONTRIBUTIONS OF THE AGRONOMY DEPARTMENT TO PHILIPPINE CROP PRODUCTION [1]

PEDRO A. DAVID
Of the Department of Agronomy

The Agronomy Department is mainly concerned with fundamental principles and practices of crop production. The principal aim of its work is to improve the methods of plant culture in the Philippines so as to produce the maximum yield of quality crop with the smallest outlay of capital. The Department tries to attain this object, mainly in three ways: (1) through introduction of various economic plants into the College for crop diversification purposes, and distribution of planting materials; (2) through scientific investigations in various phases of crop production; and (3) through giving the people the benefit of these investigations by the dissemination of useful agricultural information through correspondence, circulars, lectures, exhibitions and the like.

PLANT INTRODUCTION AND DISTRIBUTION

The Department of Agronomy has already introduced no less than 19,360 samples of different economic plants and seeds into the College of Agriculture from various parts of the Oriental and American tropics, as well as from different provinces of the Philippines. This important work of the Department has resulted in bringing into culture a good collection of numerous valuable specimens of economic plants in the Economic Botanical Garden and Experiment Station farms of the College. The number of plants introduced into the College of Agriculture since its establishment up to June 14, 1934 is represented by more than 126 families.

The Department of Agronomy in addition to introducing different species, varieties and strains of plants for tests in the College farms, distributes tested seeds and other planting materials to farmers. All the planting materials sent out had been actually raised and tested in the College of Agriculture Experiment Station farms. In recognition of the high quality of the materials distributed by the College the farmers are willing to pay a higher price for our seeds and plants than for ordinary planting materials. As an illustration, farmers pay ₱6.30 a ganta for our Excelsa coffee

[1] General contribution from the College of Agriculture No. 416.

seeds, and the demand is so great the Department can not fill all the orders. Some farmers buy stems of our high yielding cassava varieties for planting purposes at 5 centavos a meter. The good reputation which the Department has built up for the quality of its seeds and plants for propagating purposes is the result of painstaking selection of seed, varieties and strains.

CROP INVESTIGATION

The research in the field of agronomy has been broad in scope and includes many crops as well as various phases of crop production. Such subjects as introduction and acclimatization of imported plants, methods of propagation, hybridization and selection, improved methods of land preparation, cultivation, harvesting, fertilization,

Fig. 1.—A portion of the south side of the Economic Botanical Garden at the College of Agriculture.

preparation of farm products for the market, fruit preservation, storage of farm products and methods of lowering cost of production are all in the Department's research program. No attempt is made in this article to review the results of the research work which the Department has performed during the last twenty-five years.

HELP GIVEN TO FARMERS

Horticultural crops. The Division of Horticulture has introduced a very large number of fruit seedlings, budded fruit plants and seeds, and given advice to many farmers on plant propagation, culture of fruits, vegetables and ornamental plants as well as on fruit preservation.

Help is extended to fruit growers in top-working undesirable fruit trees. With this help the growers can, for example, change their sour santol trees into sweet kinds, convert non-bearing macopa trees into bearing. The Division with top-working has improved some avocado, mango, sampaloc and other fruit trees.

The Division has succeeded in making wines from different kinds of fruits. It is a matter of pride with the Agronomy Department to be able to serve these wines at banquets given in the College of Agriculture. These vintages have aroused the interest of some fruit growers and other classes of people as to the possibility of our cultivated and wild fruits as materials for wine manufacture.

Permanent crops. The Division of Permanent Crops has introduced and tested a number of promising varieties of coffee, coconut, abacá, African oil palm, agaves, spices, cacao, derris, etc. Many of these plants show promise as crops for diversifying Philippine agriculture.

Formerly, the coffee trees in the Philippines were all of the Arabica type. In 1889, the devastating leaf blight appeared causing great damage and so reducing the production that coffee was no longer exported from the Philippines. The Agronomy Department in 1915 began to introduce disease-resistant varieties of coffee from other tropical countries for trial on the College Experimental coffee farms and in other regions in the Philippines. These varieties have been tried and several selections of the best made. As a result of these trials, Excelsa coffee has been found to be satisfactory. It grows luxuriantly and requires a minimum amount of labor in its care. The seed harvested from the selected coffee trees in the College cultures has been distributed to interested farmers in the different parts of the Islands to help revive the coffee industry in the country. Private plantations have been established from the selected seeds produced by the Agronomy Department. Several such plantations are located in Laguna Province. A class survey of the trials outside the College in 1933 showed that *Coffea excelsa* A Chev. is being successfully grown in this province. Most of the plantations are located in the foothills.

Seedlings and seed of Robusta coffee, a variety quite resistant to the coffee rust have also been distributed by the Department. In 1927, budded plants of Kawisarie B coffee, a hybrid between Arabica and Liberica coffees, were introduced into the College; a number of growers in different parts of the country have volunteered to test the seedlings of this coffee. The seedlings, however, are not

as desirable as budded plants, but these can not be made available as readily as the seedlings.

Annual crops. The Division of Annual Crops has distributed to farmers large amounts of seeds of Ami soybean, rice pop corn, selected Ramai and Elon-elon rice varieties and different kinds of cover and green manure crops especially adapted to certain parts of the Philippines. It has introduced and tested high yielding foreign varieties of cereals, legumes, forage, cassava, tobacco and cotton.

In 1919, the Division investigated the possibilities of growing chewing tobacco and tobaccos for blended cigarettes. Four varieties

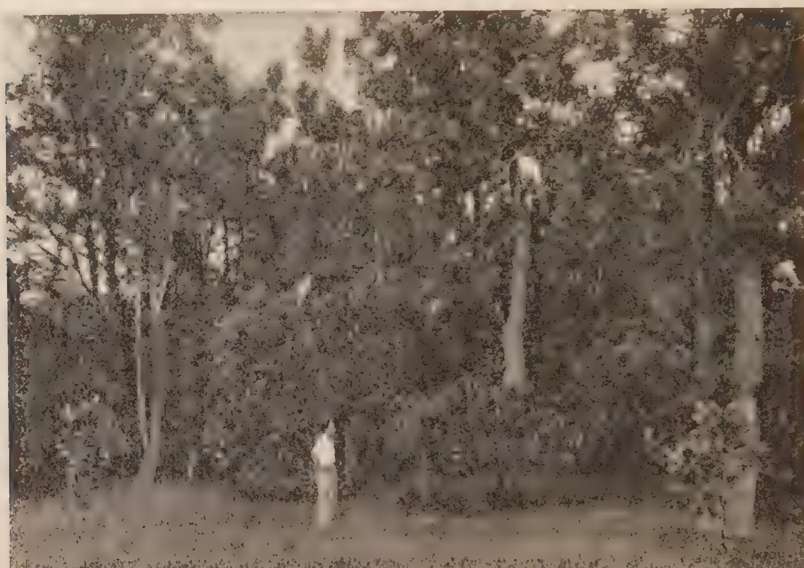


Fig. 2.—A plantation of Excelsa coffee under Australian Silky Oak, *Grewillea robusta* in the Experiment Station, College of Agriculture.

of tobacco from the United States and three from British-American Tobacco Co., in China were introduced. It was found, among other things, that the imported varieties could be used for making blended cigarettes, as tested and approved by many cigarette manufacturers in Manila. The results of the test awakened interest in Philippine tobacco men in the production of tobaccos for blended cigarette purposes. It was also found that with necessary equipment for its manufacture we can use the imported varieties for chewing purposes or making into plug tobacco.

Persistent efforts have been made in the Division to select the varieties of rice which will give the highest yields under Philippine

conditions. As a result of this work selected seeds of Elon-elon and Ramai rice varieties have been sold to many farmers. Seeds of these varieties are now grown on a commercial scale in the municipality of Los Baños in which the College is located.

The total number of introductions of adlay, broom corn, corn, millet, pop corn, rice, sorghum and wheat from 1911 to 1934 is 1,558. Each of these has been acclimatized and carefully tested on a semi-commercial scale in the Division cultures. All the varieties which proved satisfactory under Los Baños conditions were given out to good coöperative farmers for commercial planting. As a result of this work, the Division has been able to isolate several important cereals which are now commercially grown in many parts of the Philippines. Rice pop corn, a variety of pop corn now being grown in many parts of the Islands had its origin in the College of Agriculture. The pop-sorghum introduced in the College from Muñoz, Nueva Ecija in 1930 has proved worthy of culture.

No less than 451 introductions have been made of batao, cowpea, mungo, patani, peanut, sesame and soybean. The Ami soybean isolated by Mr. Sabino Q. Ami, a former agronomy student, is now commercially grown in many parts of the Philippines. Of the 13 varieties of soybean introduced from Lingnan University, Canton, and College of Agriculture, National University, Nanking, China, 7 varieties are doing well and are being rapidly multiplied for distribution to Filipino farmers. Of the varieties of peanut introduced, the Valencia was found to be the best both in the production of pods and straw. In the production of pods, Spanish White ranks second. Numerous requests for seeds of these peanuts have been received.

Of the forage and pasture plants 23 different varieties have been introduced by the Division and distributed for testing in different parts of the Philippines. So far, the best ones are the Guinea, Napier, Para, Guatemala, dallis, manimanihan, soybean, tapilan and cadios. Sudan grass and velvet bean are showing good promise as pasture plants.

There have been 343 different introductions of arrow-root, cassava, dasheens, edible canna, gabi, ginger, sincamas, nami, sweet potato, ubi and tugue from 1911 to 1934. From these introduced root crops, the Division of Annual Crops found very high yielding varieties of cassava, such as Aipin Manteiga, Mandioca Itaparica, Mandioca Basiorao, Mandioca Creolinha, and seedlings Nos. 239, 2536, 3718, 3886. Of the root crops mentioned, cassava is at the present time of the greatest interest. According to the records, cassava has been under study in the Division since 1910. The studies

have been both agronomical and industrial. Recently, the Department of Agronomy issued Circular No. 21 under the title "Cassava Growing and Cassava Starch Manufacture" as a general answer to numerous requests for information about the culture of this crop. Quite a number of Filipino planters have come to the College of Agriculture to study the culture of cassava and its manufacture into starch. The Department of Agronomy has distributed large quantities of cuttings of the superior varieties and these should spread over the Philippines. The demand for College cassava planting materials is so great that orders can not be filled at once; there are many standing orders for cuttings.

Plant breeding. In the Division of Plant Breeding, superior hybrids of sugar cane and pineapple have been produced and released to planters. Of the cane hybrids which have been grown by planters on a large scale, P. S. A. 14 and P. S. A. 7 are worthy of mention. These two seedling varieties of sugar cane were selected by the Philippine Sugar Association from seedlings produced by the Division during the sugar cane season of 1925–1926. They were crosses between P. B. 119 (selfed) and C. C. A. 87 (a cross between Mauritius 1900 and talahib). These important sugar cane hybrids are now grown commercially in some important sugar provinces, especially Laguna and Pampanga. Another sugar cane hybrid recently found desirable for distribution to farmers is C. A. C. 111.

The pineapple hybrids produced in the Division are better table varieties than their parents—the Smooth Cayenne, Red Spanish and Buitenzorg. The hybrids produce fruits which are sweeter and of better quality and flavor than the parents. Planting materials of one of these superior pineapple hybrids have been distributed to farmers.

A summary of the various services rendered by the Agronomy Department may be given as follows:

1. The Department is called upon for service in modern scientific and practical methods of crop production, and also in the beautification of the grounds of many public institutions.

2. It introduces important economic plants and seeds from different parts of the world for diversifying Philippine agriculture.

3. It creates and improves new varieties of agricultural farm crops that are adapted to Philippine conditions and then distributes them to farmers.

4. It undertakes research work on various phases of crop production. It is of interest to note in this connection that of the 948 investigations carried on by undergraduate and graduate students

in the different departments of the College in the last twenty-five years, 443 or 46.7 per cent of these were conducted under the Agronomy Department.

5. It gives instructions in modern and scientific methods of farming that are suitable to Philippine conditions.

6. It coöperates with Filipino and foreign farmers through various extension means, such as direct instruction, popular articles, circulars, correspondence, lectures and radio talks, summer short courses, participation in municipal, provincial, and insular fairs.

THE MAQUILING NATIONAL PARK

Mount Maquiling was formerly an old Spanish hunting reserve. In 1910, it was proclaimed as Mount Maquiling Forest Reserve. Ten years later, on December 4, 1920, it was converted into Maquiling National Botanic Garden. With the passage of the Parks Law in 1933, the Garden was reserved, set apart, and designated as the Maquiling National Park, the first park established under the National Parks Law. The Chief of Division of Forest Studies and Research is Superintendent of the park.

The park which embraces the greater portion of Mount Maquiling is the most accessible forest near Manila, being only 70 kilometers by road from the city. It can be reached by water, railroad and road. It is on the road connecting Manila with the famous Pagsanjan Gorge, and Botocan Falls where the four million peso hydroelectric plant was built by the Manila Electric Railway Company.

One of the important developments of the park is the Maquiling Road which starts from the Oteyza Loop on the Forestry Campus and will extend to the third peak of Mount Maquiling. This road has been laid out with a reasonable grade of from 5 to 10 degrees throughout, following the general contour of the mountain. It is surfaced with crushed rock for 2.5 kilometers. During the dry season, one can drive an automobile over it for 4.5 kilometers or to the Mud Spring.

The Maquiling Road is being constructed to make accessible to the public the flora and fauna of the mountain. From the main road, trails branch and pass through the various forest types. A plan is under way to connect the main route with the Economic Garden at Los Baños.

Before long, it is hoped that the summit may be reached by motor. Here, one can see the neighboring low lands, several towns, Laguna de Bay and the crater of Taal Volcano.

OUTSTANDING RESULTS OF AGRONOMIC AND HORTICULTURAL RESEARCH [1]

L. G. GONZALEZ
Of the Department of Agronomy

In the twenty-five years of its existence the Agronomy Department has contributed to Philippine scientific literature 615 papers. Of these 194 were prepared by members of the faculty, and the remaining 421 were theses of graduating students who majored in the Department. These theses were planned by and the experiments performed under the direct supervision of members of the staff. Of the theses, 127 have been published, abstracts made of several and published, and the rest are awaiting publication. In addition to these contributions there are other researches under way in various stages of completion.

In presenting the results of the agronomic and horticultural researches only the most outstanding ones will be discussed. They are treated by crop, arranged alphabetically.

CACAO

In a test of several cacao varieties, Forastero proved the best under local conditions. The trees planted under shade grew more vigorously and gave considerably higher yield than those planted in the open. Dapdap and madre cacao were found to be good shade trees (David, 1929).

Besides budding, grafting and inarching, the cacao plant can be propagated with reasonable ease by marcottage and by stem cuttings (Anioay, 1932).

For raising cacao seedlings, a soil medium made up of equal parts of garden soil and compost was found advisable (Madrid, 1933).

COCONUT AND OTHER OIL PLANTS

Coconut. A *varietal study* of coconuts in Laguna and Tayabas provinces showed that there are eight fairly distinct varieties in these regions (Desembrana, 1923).

In *propagation* studies it was found that fully ripe nuts for seed proved superior to nuts of any other age, the nuts to be planted

[1] General contribution from the College of Agriculture No. 417.

whole, on the side, and to be transplanted when 15 to 30 cm. high (Espino, 1923).

It was found that round nuts were heavier, germinated earlier, produced more leaves and roots than oblong nuts (Maceda, 1933).

There was no consistent relationship between size and shape of nuts and percentage of germination (Bayog, 1929). One week of drought was not very detrimental to coconut seedlings but two weeks of dry weather retarded growth considerably.

Round nuts were found to contain more meat than other shapes and were recommended for *copra production.* Other types of nuts had thick husks. The thickness of the shell of all types was variable (Lacson, 1921; Novero, 1922).

Studies on *rate of growth* of coconut trees showed that it varied according to the age of the tree and that it was directly related to yield (Almazan, 1922).

Palms 10 to 30 years old still had the ability to increase the number of leaves. The yield of green nuts increased as the age of the trees advanced (Almazan, 1922). A study of flower biology showed that July and August were the most favorable months for the production of inflorescences, and November and December the most unfavorable. The largest number of female flowers were produced by the inflorescences that appeared during April, May, June, and July. The months from September to January were unfavorable for the production of female flowers (Jimenez, 1926). The coconut is both close- and cross-pollinated. Male flowers open at about six o'clock, and their anthers dehisce at about eight o'clock in the morning. The female flowers in the same cluster become receptive after two or three weeks from the time of the appearance of the inflorescence (Aldaba, 1921).

A study of the *growth of nut* showed that at first the nut grows in length faster than in width, then faster in width and then faster in length. There are three more or less distinct stages in the development of the nut: (1) the first stage lasting up to the age of 4–5 months, the growth is mainly in area of the husk and shell; the cavity assumes almost maximum space during this period. (2) The second stage lasts till the nut is 6–8 months old; the meat appears and the husk and shell grow rapidly in thickness. (3) The third stage is from the time the nut is 8 months old until maturity. During this period the husk, shell, and meat change in color (Fandiño, 1928).

Different phases of copra production have been studied. It appears that *copra may be prepared* in the shell of the nuts without the use of artificial heat, if the germination of the nuts is prevented.

The copra produced in the shell had as much oil as the ordinary copra in the market and was superior to it in color, being almost white (Rocafort, 1922).

Various types of copra driers are used in the Philippines. A study of their initial cost, efficiency and cost of operation was made in 1927. The Sariaya type was found to have an advantage over the Laguna and ordinary Tayabas types. Sun-dried copra keeps longer than the kiln-dried. It has the best quality and gives the most profit, if the weather is favorable, but it takes a longer time to make copra this way than by artificial drying. Tayabas coconuts produce more copra than Laguna nuts of the same size (Cruz, 1930).

In an experiment on the *production of coir* from coconut husk, it was found that the best retting solution was either 10 per cent sodium hydroxide or 10 per cent potassium hydroxide. Green husks produced more fiber than dry husks. Mañgipod produced the least fiber while the other varieties had about the same percentages. The fiber of one variety obtained from green husk was found to be the same in strength as that obtained from the dry (Flores, 1923).

Peanut, sesamum, African oil palm, lumbang and a few others have been included in our research work on oil-bearing plants.

COFFEE

Beginning in 1915, a study of the variation in *yield among coffee* trees has been carried on. About 4,000 trees belonging to the Robusta, the Excelsa, and Liberica varieties were included in the study (David, 1932). The highest individual record for Robusta was 6,790 grams and the lowest, 369 grams; for Excelsa, maximum was 10,692 grams, minimum, 800 grams; and for Liberica, maximum was 8,270 grams and minimum, 500 grams. The average yield of fresh berries in kilograms of all trees studied was: Robusta, 1.7, Excelsa, 2.7, and Liberica, 2.2. Marketable beans obtained from the berries were found to be 25 per cent for Robusta, 15 per cent for Excelsa and 11 per cent for Liberica (David and Natino, 1932).

Coffee seedlings have been successfully shield budded, inarched, and cleft grafted and old trees have been top-worked by bark grafting (Romero, 1930). For grafting purposes terminal branches were found more desirable than lateral shoots as the latter had the tendency to extend laterally at the expense of upward growth. Stem cuttings were rooted easily, using hard wood and a 1.5 per cent solution of potassium permanganate as a stimulant (Reynoso, 1933). Other lines of coffee work investigated by the Department were the

effect of soil media on growth of seedling, methods of shipping seedlings, control of coffee rust with Bordeaux mixture, and shade for coffee.

CORN

Of 30 corn *varieties tested* the Native Yellow Flint proved to be the heaviest yielder (Macasaet, 1918). The Lagkitan, a semiglutinous variety, proved to be suitable for boiling on cob at early milk stage. This variety may be used as a substitute for the sweet corn which does not grow well under our conditions.

The *season* favorable *for corn production* was found to be when the rainfall was about 312.6 mm. for the whole season (Menor, 1927). The wet season crop was found to give more yield than the dry season and it also costs less to produce on the basis of yield. A planting distance of 1 m. by 80 cm. was found to be best for Native Yellow Flint, closer planting resulting in an increase in the total weight of stover at the expense of the ears, while wider planting resulted in a decrease in total weight of stover and ear (Macasaet, 1918).

In different *fertilizer experiments* a combination of 200 kgm. tankage, 175 kgm. basic slag and 350 kgm. kainit gave the highest increase in yield, being 476 kgm. more husked corn to the hectare than the control. In another experiment using Ammo-Phos and Leunaphos a better increase in yield was obtained from an application of 100 kgm. per hectare of Leunaphos; the increase in yield was 11.4 cavans more than the control (Andaya, 1932; Yatar, 1934).

Experiments on storage of corn showed the advisability of first thoroughly drying the seeds and keeping them in air-tight containers. If this could not be done it was found to be fairly satisfactory to store the dried grains with some gaseous disinfectants as carbon bisulfide, with naphthalene or with absence of oxygen in the seed container (Reyes, 1933). When ears were stored with husks on, the husk afforded additional protection to the grains (Aragon, 1934).

COTTON

Preliminary tests of varieties showed that Acala and Cleveland Big Boll were the highest yielders of lint (Legaspi, 1934). Varieties Pima Egyptian, and Sea Island were found promising and are being observed further. In cultural studies it was found that the best distance for planting was 50 cm. by 70 cm. (Espinueva, 1934); that a 3–9–3 fertilizer mixture applied at the rate of 400 kgm. per Ha. increased the yield three times (Apellido, 1934), and that the best time for cotton planting in this locality is from September to October (Mendoza, 1922).

Selection studies made have shown great possibilities for improvement of the native varieties of cotton. The Ilocano Light Brown variety of cotton has been found to be a hybrid and is not a desirable variety to grow where uniformity of the color of lint is desired (Abrenica, 1933).

FIBERS

Abacá. In *variety tests* in abacá in which over 50 kinds were grown under local conditions, varieties Bongolanon, Visaya, Sinaba, Libuton, Sugmod, Tangonon, Punucan and Maguindanao proved the most promising (Espino and students, 1923).

As far as can be determined, the experimental germination of abacá seeds and the *growing of seedling abacás* for the production of new varieties were initiated in this Department (Mendiola, 1923). Under ordinary conditions the seeds do not germinate in 25 days but when they were soaked for 10 minutes in water at 50°–60°C. germination was considerably hastened. The optimum soil moisture content for the abacá seedlings was found to be 70 per cent.

The *breaking strength* of a sample of fiber was found to be directly proportional to its tensile strength. The breaking strength seems to be directly related to the thickness of the cell wall. The fiber cells from the middle of the sheath were found to be larger than those from the edges of the same leaf sheath of the same variety. As a rule the fibers from the middle of the leaf sheath of the same variety were coarser and had greater tensile strength than those from the edges (Espino and students, 1923).

Agaves and related fibers. A comparative study of maguey, Mauritius hemp, sisal and zapupe showed that leaves of Mauritius hemp were about three times as heavy as maguey. Compared with maguey, Mauritius hemp produced very little fiber, although the two fibers were about the same length. Sisal had the coarsest fiber and maguey the finest. Mauritius hemp was found to be weak compared with the other species, although it had the greatest stretching power (Espino and Novero, 1923).

Bast fibers. A search for plants that may be used as sources of fiber for twine and sack manufacture resulted in showing that *Urena lobata* Linn., *Hibiscus cannabinus* Linn., *Corchorus capsularis* Linn., and *Crotolaria juncea* Linn. are promising. With the present cost of labor, however, it was found that it is cheaper to buy the imported twine and sacks than to make them locally out of the fibers of these plants (Albano, 1915; Baltazar, 1930).

FIELD LEGUMES

Soybean. In field tests of different varieties, Ami gave the highest yield (Layosa, 1918). Other promising varieties are the Yue Yin September Yellows, Szechwan Bar District Red, Peiping Fenglein White Eyebrow, Peiping Brown, and the American Black (Aragon, 1934). Ammo-Phos fertilizer test showed that it did not pay to use it with soybean (Aragon, 1934). It was found that it would cost ₱86.90 to produce a hectare of wet season soybean and ₱62.39 to produce the dry season crop (Rozul, 1932).

Peanut. In field tests including Valencia, Kinorales, Tarlac, Lemery, Vigan Lupog, and Spanish Red Varieties, Valencia proved the highest yielder both in the wet and the dry season cultures. Spanish White came next in the production of pods, but was third in the production of straw. Lemery came second to Valencia in production of straw, but fifth in production of pods (Battung, 1933).

It was found that the oil content of peanut was increased following the application of fertilizers (Silayan, 1917). It cost ₱86.57 and ₱77.22 to produce a hectare of wet and dry season cultures, respectively.

Cowpea. Of all the varieties of cowpeas tried the New Era, the White, and the Brownish Red varieties gave the highest yield of seeds and vines in both the wet and dry season plantings (Aala, 1933).

Mungo. In a study of mungo types there were found three main groups based on color of the seeds; namely, yellow, green and black. Strains Urdaneta Green, Lipa Yellow, and Rosales Yellow were the heaviest yielders of green materials, while Aliaga Black, Shiny Green, and Dull Green strains from Binañgonan Green were highest producers of seed. The best time for planting mungo was found to be the earlier part of the dry season. Application of ash increased seed production and hardened the body of the plant (Caguicla, 1933).

Sesamum. The yield was considerably increased by using selected seeds and growing them in plots. The bases for selection were strength of stem, resistance to disease, uniformity to type, resistance to drought, and productiveness. A higher yield was obtained in the dry season planting than in the wet season (Zulaybar, 1914).

FLOWERS

Annuals. As a result of various variety trials of imported flowering plants we now have 73 kinds, some of which are quite rare. Fourteen kinds did not prove successful under our conditions.

The best time for planting annuals was found to be from November to March although most of the plants may also be planted

from June to October. The following plants were found to grow only from November to May: Anthirrhinum, aster, baby's breath, California poppy, carnation, centaurea, dianthus or pinks, everlasting or straw flower, hollyhock, pansy, phlox, portulaca, sunflower, and viola (Dawis, 1926).

Shrubs. Over 50 kinds of shrubs both of the flowering and foliage types have been under observation in our gardens. Among the more important kinds may be mentioned *Acalypha, Psenderanthemum, Euphorbia, Bauhinia, Brunfelsia, Cassia, Clerodendron, Cordyline, Cupressus, Jacobinia, Duranta, Erythroxylon, Jasminum,*

Fig. 1.—A caimito marcot being inarched to caimito seedlings. In this way a great deal of propagating material is saved from the marcot and at the same time inarching is made very practicable. First pot on the right and first on the left are successful inarched plants.

Allamanda, Sanchezia, Strobilanthes, Thumbergia, Stenolobium, Randia and *Posoqueria.*

Trees. Of recently introduced ornamental trees, the Brazilian fire tree (*Schizolobium excelsum* Vog.), *Cassia javanica* Linn., the candle tree, the African tulip tree, and the sausage tree are among the most promising.

What is, perhaps, the richest collection of calachuchi and Hibiscus in the Philippines may be found in the College (Mendiola and Capinpin, 1923; Mendiola and Unite, 1924; Mendiola, 1926). To

date there are more than 40 varieties of each, and many more are being produced through seed propagation. Also, there are many varieties of *Anthurium* (Dawis, 1930).

In experiments with Begonia, it was found that an application of 5 grams superphosphate in a No. 5 pot was the best (Quintos, 1933) and that afternoon sunlight was better for foliar growth than morning sunlight of the same duration of exposure (Fontanilla, 1933).

FORAGE AND PASTURE PLANTS

Separate studies were made on the cultural requirements of the barit, *Leersia hexandra* Sw. (Ordoveza, 1928), Guatemala, *Tripsacum laxum,* dallis, *Paspalum dilatatum* Poiret., cahumayhumay, *Andropogon intermedius* R. Br. (Paggao, 1934), manimanihan, *Desmodium capitatum* Burm. f. (Arcedo, 1933), and *Indigofera hendecaphilla* Jacq. (Fajardo, 1932).

Studies on Jaragua grass, *Melinis minutiflora* Beauv., showed that the plant is capable of yielding 11,581 kgm. fresh weight during the wet season and 1,223 kgm. during the dry season. Analysis of the Jaragua grass silage showed that it contained 63.6 per cent moisture, 1.11 per cent fat, 2.71 per cent ash, 2.26 per cent protein, 15.54 per cent crude fiber and 14.98 per cent carbohydrate. The fresh Jaragua grass was found to contain 81 calories per 100 grams sample (Obillo, 1934).

FRUITS

Atemoya. Repeated trials in introducing cherimoya in Los Baños failed, so attention was turned to the introduction of the atemoya, the fruit nearest in flavor to the cherimoya. The atemoya cleft-grafted to the custard apple does well under conditions in Los Baños. It was also successfully inarched with atis and guayabano as stocks (Gonzalez, 1929).

Avocado (*Persea americana* Mill.) *Avocado plants* from seeds are so variable that each seedling grown is a form by itself. This is advantageous from the standpoint of originating new varieties. In fact we now have avocado trees which originated as seedlings maturing as early as April and others ripening as late as November. The value of this extension of the season will be better appreciated when it is remembered that formerly avocados were produced only from June to August. A few seedlings in which are combined the desirable characteristics of certain standard varieties have been selected (Gonzalez, 1932).

Because avocado seedlings vary it is necessary to use *asexual methods of propagation* to perpetuate desirable characteristics of the parent plant. Results of experiments show that the avocado seedling may be inarched, shield-budded, cleft- and bark-grafted (Gonzalez, (1925).

Results so far obtained of studies on storage of the avocado showed that at 10°C. the life duration of the mature fruit may be increased to at least three times that at ordinary room temperature (Gonzalez and San Pedro, 1933).

In *preservation* the best result was obtained by canning the ripe fruit with the use of a solution made up of two parts sugar and one part water alone, or in combination with 1 to 2 per cent acetic acid in the proportion of one syrup to one of the acetic acid solution. The degree of heat of sterilization should not exceed 70°C. and the duration of heating not more than 15 minutes (Torres, 1934).

Balimbing (*Averrhoa carambola* Linn.). The study on forms of balimbing resulted in the acquisition of a sweet and large-fruited kind. It was found that this plant can be shield-budded and bark-grafted as well as marcotted and inarched. We have on the College Campus trees of the sour type successfully top-worked to sweet forms (Gonzalez, 1931).

Bananas. Tests of different varieties of bananas gathered from various parts of the world show that under conditions in Los Baños only a few are of commercial importance. The list includes our leading varieties; namely, Latundan, Lakatan, Buñgulan, Saba, the Chinese Dwarf, Ambon, and Katale (Teodoro, 1915; Quisumbing, 1919; Gonzalez, 1931).

Fertilizer test on bananas using the Chinese Dwarf and different proportion of NPK showed the application of 407.50 grams of $NaNO_3$ and 98.60 grams K_2SO_4 per plant to be the best. Height of plant, diameter of trunk, number of suckers produced, and weight of bunches were considerably increased (Manipula, 1934).

The optimum temperature found for storing banana was 15°C. Above this temperature the keeping quality was shortened and below, abnormalities in ripening were observed (Pascual, 1930). Ripe bananas were successfully preserved by cutting them into slices and drying them in the sun or in an oven at 70°C. The dried strips may be eaten as such or may be used for cooking purposes. If kept dry, they last for about a year.

Caimito (*Chrysophyllum cainito* Linn.). Caimito, or star apple was successfully bark-grafted in 1931 (Gonzalez and Guzman, 1931). Likewise the plant was successfully inarched, and marcotted

but could not be shield-budded nor cleft-grafted. The caimitillo did not prove to be a good stock for star apple.

Chico (*Achras zapota* Linn.). The usual practice is to grow this delicious fruit almost wholly from marcots (Villodres, 1930). In this College we have grown it from inarched, cleft-grafted and bark-grafted plants. Propagation by shield-budding did not prove successful (Gonzalez, 1927).

Studies of storage temperatures of chico have been made. Of the different temperatures used 15°C. was found best for storage of green and turning and 0°C. for the ripe fruits (Campo, 1933).

Citrus. Citrus fruits grown in the Philippines respond favorably to coloring treatment with ethylene and acetylene, (Gonzalez and Garcia, 1932). The optimum concentration of ethylene for coloring Batangas mandarin, cahel, lime, lemon and culubot was 1 part of gas to 20,000 parts of air. For pummelo and calomondin 1 to 4,000. The fruits were exposed to the gas from 110 to 120 hours at room temperature. When acetylene was used the optimum concentration was found to be 1:4,000.

Green but mature mandarin fruits were found to have a slightly better keeping quality than the tree-colored fruits. To a certain extent large fruits kept better than small ones. Those stored at different temperatures kept as follows: At 18.3°C. to 24.4°C., two weeks; at –3.3°C. to 6.6°C., four weeks; at 2.2°C. to 6.6°C., six weeks. Toward the end of the storage period marked improvement in flavor was noted and the fruits assumed a uniform orange color (Gonzalez, N., 1932).

Kaki (*Diospyros kaki* Linn.). The results of grafting the kaki on two-year old sapote seedlings are very promising (Gonzalez and San Pedro, 1934).

The kaki was also found to be easily propagated from root cuttings. The process consisted in severing a few roots without digging them up and waiting until sprouts appeared on the severed roots.

Lanzon (*Lansium domesticum* Correa). Experiments in asexual methods of propagation of the lanzon proved that cleft-grafting of seedlings two to three years old was the most successful. Shield-budding failed and bark-grafting of five- to ten-year old seedlings gave a low percentage of success (Gonzalez, 1923). The propagation of this plant by stem cutting was found to be not practical (Polo, 1925).

The optimum storage temperature found for the lanzon was 13°C. to 16°C. At this temperature ripe lanzones remained in excellent condition for 13 days with only 9.48 per cent decay. Of this

amount, 4.06 per cent could be avoided by more careful picking. At temperatures below 13°C. there was noted a browning of the rind which made the fruits unattractive. At 20°C. and above, they rotted rapidly (San Pedro, 1932).

Lychee (*Litchi chinensis* Sonn.). Results of an investigation to determine the extent of non-flowering among lychee in some parts of Bulacan, Pampanga, Laguna, Rizal and Manila showed that of about fifty trees studied, not a single one had ever produced fruit. The trees were from 15 to 50 years old, in a thrifty condition, and were planted in different soils and environment. In three cases three Chinese experts on lychee failed to make the trees bear fruit (Gonzalez, 1922).

Experiments on branch pruning, ringing, smudging, irrigating, and fertilization of lychee trees about 15 years old were not effective in forcing the trees to flower (Gonzalez and San Pedro, 1932).

Mango (*Mangifera indica* Linn.). Smudging as a means of forcing the mango tree to flower was found to be much more efficient than root pruning, branch pruning, wounding the main stem, ringing the branches, application of salt on the root, application of fertilizers, or irrigation (Gonzalez, 1923). Studies on catalase activity of the leaves and other tissues of the mango suggest the possibility of using this treatment as a means of determining the suitability of the tree for smudging (Caguicla, 1930; Guzman, 1932).

The mango fruit has a short life duration which is a great handicap in developing mango production for export. Studies on storage temperature requirement of the fruit showed that the marketable period could be extended to 20 days if the newly picked matured fruits are kept at 2.2°C. Below this temperature the fruit had the tendency to blacken and at higher temperatures the life was considerably shortened (Higgins and Punzalan, 1925; Matela, 1929).

A ripe mango fruit preserved by freezing is good only while in the frozen state and should be kept in this condition if it is desired to keep it for a long time. Once thawed, the fruit soon ferments and at ordinary temperature it begins to spoil within 24 hours. Canned mangoes kept for a much longer time even at room temperature. In addition to common methods of preserving the ripe fruit by cooking, the sliced flesh of the mango proved to be well adapted for drying in the sun or in an oven at 65°C. The use of sulfur fumes restored the original yellow color of the fruit from the brownish discoloration resulting from exposure to the air for a long time (Zamuco and Lumibao, 1924).

Marang (*Artocarpus odoratissima* Blco.). Experiments on the methods of asexual propagation of this plant including marcottage (Fabello, 1929), budding, grafting, propagation by root and stem cuttings (Gonzalez, 1927) failed to give good results. Other species of *Artocarpus* including jakfruit, camansi, antipolo, and anubing, also failed to give satisfactory union.

Papaya (*Carica papaya* Linn.). Results of studies on cold storage of papaya show that ripe fruits kept well for three weeks at a temperature of 1.11°C. Mature, unripe fruits failed to ripen normally at temperatures lower than 13°C. At temperatures 13° to 16°C. there was slight ripening but the results were unsatisfactory for green and turning fruits (Enrile, 1931).

In one experiment pruning did not change the sex expression of male papaya trees (Gonzalez, 1923). In another experiment, one male tree pruned changed in sex expression and produced fruits although it did not assume a form completely female (Reyes, 1925).

Pineapple (*Ananas comosus* (Linn.) Merr.). To a large extent the age of planting material in pineapple influences the season of bearing of the plant. Propagating materials collected from plants maturing fruits in November and December when planted showed that only the old planting materials fruited in November and December, and this only lasted to the second bearing after which the plants bore fruits in May and June, the regular season (Gonzalez, 1931).

Variety tests with pineapple showed the superiority of Smooth Cayenne for commercial purposes and varieties Queen and a variety from Java for home use. Crossing Smooth Cayenne and Red Spanish and Smooth Cayenne and Buitenzorg variety produced very satisfactory table hybrids (Mendiola, et al, 1934).

Pili (*Canarium ovatum* Engl.). Studies on asexual methods of propagation of the pili show that this plant may be propagated by inarching and marcottage. When seeds are grown they should be soaked in tap water for 48 hours before planting or the hard shell may be partly cracked or entirely removed (Cabrera, 1933).

Different methods of removing the husk of pili were used, among these that of soaking in water at 40° to 50°C. was found to be most practical (Austria, 1933).

Rimas (*Artocarpus communis* Forst.). It was found that this tree can be propagated by marcottage, a method more practical than the common way of growing it by root cuttings. Propagation by shield-budding, cleft-grafting, and bark-grafting did not prove suc-

cessful, even with the use of other species of *Artocarpus* for stocks. (Gonzalez, 1928).

Santol (*Sandoricum koetjape* (Burm. f.) Merr.). Undesirable

Fig. 2.—Undesirable santol tree top-worked to a choice variety four months after the operation. Gunny sack around the trunk protects the tree against sun-scald and bamboo poles support it against high wind.

trees were successfully top-worked by bark-grafting (Gonzalez, 1934). Young seedlings responded favorably to cleft-grafting and with difficulty to shield-budding (Arana, 1934).

Sapote (*Diospyros ebenaster* Retz.). A tree bearing seedless fruits has been located and attempts are being made to graft scions of this tree on to sapote seedlings (Gonzalez and San Pedro, 1934).

Siniguelas (*Spondias purpurea* Linn.). It was found that the stone of this fruit did not contain developed seeds. Trials in budding and grafting gave poor results but propagation by cutting proved more satisfactory. For this purpose the best results were obtained when large sized branches were used, cut to about a meter in length and gathered from the tree about February (Morales, 1931).

Young fruits of the siniguelas and the yellow mombin were found to be suitable as an ingredient of mixed pickles. For this purpose the fruit is picked before the stone hardens (Odjiar, 1933).

RICE

The results of the Department's variety tests on rice have showed that Binocaue, Quinastila, Kinanda, Pinursigue, Carreon, and Initiw are the best yielders of all the upland varieties studied and Iroy, Binalayan, Ramai, Elon-elon and Khao Bai Sri the heaviest yielders of all the lowland varieties tried (Morada, 1921; Aragon, 1933). Variety Ng Tani, introduced from Siam is very promising (Jayme, 1934).

In selection work, 16 strains of Ramai rice were chosen from 318 strains for high yield. Their computed yields varied from 93.66 to 123.65 cavans per hectare (Mejia, 1932; Bayan, 1934).

Results of investigations pointed to the close relationship between rainfall and yield (Abesamis, 1922). The best result in germination was obtained from seeds soaked in water for two days and planted two days later. A delay of more than three days in sowing decreased the percentage of germination considerably. Saturated soil proved more desirable than either the slightly wet soil or soil immersed in water (Hernandez, 1926). As the seedlings became older, but not over six weeks, the number of tillers was increased. Beyond six weeks, however, there was a significant reduction in the tillering power of the plants. Planting the seedlings at a distance of 50 cm. by 50 cm. proved more desirable than planting farther apart (Calvo, 1927).

When the seeds were planted direct to the field, planting them one grain to a hill proved more desirable than when a number of seeds were planted, as is usually done by the farmers. With the drill method, using a machine gave a better crop than by the native

method, (Marilao, 1922). In general, the broadcast lowland rice yielded less than the transplanted rice (Capili, 1932).

Pruning the leaves at the early stage of growth of the seedlings seemed to be conducive to higher yield, especially when the plants had the tendency to lodge (Andaya, 1926; Punzalan, 1923).

It was also shown by studies that lowland culture gave higher yield than upland culture, although it costs more per unit area to raise lowland than upland rice (Isidro, 1920). Rice fields previously grown to cogon gave poor rice crops (Abrajano, 1922).

Fertilizer tests on rice showed that under College conditions either of the following applications per hectare may be used to se-

Fig. 3.—Rice variety Ng Tani introduced from Siam. This variety promises to out-yield Elon-elon and Khao Bai Sri and is of superior eating quality.

cure increased yield in rice: 100 kgm. ammonium sulfate, 150 kgm. Corona Arroz, 150 kgm. Corona No. 1, 150 kgm. Ammo-Phos, 150 kgm. Hoz, or a home-mixed fertilizer containing nitrogen and potash at the rate of 100 kgm. sulfate of ammonia and 20 kgm. sulfate of potash. The varieties used in the experiment were Ramai and Elon-elon (Benitez, 1933; Butac, 1933; Villanueva, 1933; Roque, 1933; Fontanilla, 1934; Asuncion, 1934; Antonio, 1934; Serquenia, 1934; Ocampo, 1934; Flores, 1934).

A survey on the comparative cost of the different methods of harvesting rice reported the following expenses per cavan: Yatab method, ₱1.08; Palot method, ₱2.01; Lingcao method, ₱1.73; Batan-

gas sickle method, ₱1.88; and the Laguna sickle method, ₱1.33 (Africa, 1920). The cost of producing rice in the Philippines was found to vary from ₱1.56 to ₱2.44 per cavan (Aragon, 1933).

ROOT CROPS

Variety tests of sweet potato gave the following as best yielders for roots and vines: Inincanto, Montevideo, Samar Big Yellow, Los Baños Red, and Los Baños White. The production ranged from 8 to 9 tons per hectare for the dry season culture. For planting, the tip cuttings gave faster growth and higher yield of roots than the base cuttings. In planting the cuttings they should be laid in a bent position (Muñoz, 1914; Merino, 1914; Tenebro, 1933).

With cassava, varieties Aipin Manteiga, Java seedling No. 1964, Mandioca Creolinha, Java seedling No. 239, and Mandioca Tapicuru were found to be high yielders of starch (Sicam, 1933). The different varieties exhibited different demands as to amounts of fertilizer. For instance, Mandioca Basiorao required 150 kgm. per hectare of Ammo-Phos for highest yield; Aipin Valenca and Mandioca Sao Pedro Preto, 200 kgm. (Gonzalez, T., 1934). In the production of gaplek, it was found that drying in the sun was the more economical. Drying in the sun cost ₱80.63 a ton and drying artificially, ₱118.20(Ganay, 1933). Fairly complete information has been obtained experimentally on cost of production of roots and cost of manufacture of starch and by-products of cassava (Mendiola, 1931).

RUBBER

Observations under Los Baños conditions showed that Para rubber grows more rapidly during the wet than the dry season. But, there did not seem to be any correlation between the weekly rainfall and the weekly growth of Hevea. Diameter growth was correlated with terminal growth. With Hevea there was a distinct periodicity in growth. Under dense shade its growth was poor, in partial shade, luxuriant, and in the open, only medium. A combination of fine clay loam and alluvial soil seemed most favorable to the growth of this plant (Sarmiento, 1916).

Propagation by budding, particularly patch budding, was found successful (Aguanta, 1932). The stem cuttings did not root (Albino, 1928).

Of the 15 superior strains of Hevea clons introduced into this College from the Dutch East Indies, 9 are living. These living clons are Ct. 3, Ct. 88, Tjirandji No. 1, Avros. 49, Avros. No. 80, Avros. No. 163, Avros. No. 152, B. D. No. 2, and B. D. No. 5 (Mendiola, 1931).

SUGAR CANE

Soaking sugar cane points in lime-magnesium sulfate mixture before planting was found to be the best treatment in increasing percentage and rate of germination. The composition of the mixture was 14 kgm. lime, 1.81 kgm. magnesium sulfate diluted to 200 gallons, and the duration of treatment, 48 hours. The treatment was fairly economical, costing about ₱3.00 to treat points for planting one hectare (Calma, 1933).

Husked and unhusked cane points were compared in percentage of germination, and it was found that the unhusked points gave the better result (Cortez, 1934). The length of the seed pieces also contributed to the success of the planting, the longer the seed pieces, the higher the percentage of germination. It was also found that plants grown from long seed pieces grew larger than from short (Alhama, 1933). Likewise it was found that top seed pieces gave a higher percentage of germination than the cut-back (Calma, 1933). When seed pieces are to be shipped a long distance, it was found to be necessary to cut them a little longer to give allowance for rotting in transit (Alhama, 1933). It was found that often the internodal part of the seed piece had a tendency to dry up to the next node. By experiment it was found that by disinfecting the ends of the points with a solution of mercuric bichloride and coating them with melted paraffin would minimize decay.

Seed pieces planted horizontally in the ground at a depth of about 30 cm., proved to be better than any other method (Reyes, 1924).

For rapid propagation, the combination of cut-back and splitting method proved the most efficient. In one investigation it was found that the tillering habits of canes grown by cut-back, splitting, and combination of cut-back and splitting methods of propagation did not materially differ. The canes were ready for another cutting-back in 7–8 months, although in some varieties they may be ready for propagation in 6 months. In the combination method of splitting and cutting-back, approximately 1,830 suckers, cut-back seed pieces, and stumps could be produced in 1 year and 3 months from an average stool of cane (Reyes, 1934). The application of ammonium sulfate at the time of planting increased the degree of tillering (Sabino, 1934).

Shallow tillage gave a higher tonnage of cane than the deep, but the deep produced higher Brix polarization and purity than the shallow (Pedroso, 1931). The cane should be cultivated frequently, up to at least, eight times. It was found that within this range there

was a corresponding increase in yield, but not beyond this frequency (Valdez, 1933). A planting distance of 66–2/3 by 100 cm. gave the highest degree of tillering (Toribio, 1928).

In intercropping ratoon canes with legumes it was found that *Calopogonium muconoides* was very effective in controlling weeds, but it had harmful effects on the canes. Soybean and peanut were found to increase the yield of the canes and saved two processes of cultivation, off-barring and hilling up when the canes are small (Valdez, 1933).

There was no significant difference between the yield of sugar cane propagated by "lalas" and by cut-back seed pieces, except that it was found that more sugar was produced by the "lalas" method than by the cut-back method (Nuestro, 1934). The detasseling did not give a significant effect on the cane and amount of sugar produced (Sabalburo, 1934).

TOBACCO

The earliest work on tobacco in the Department was in 1914 when trials were made in the growing of Turkish tobacco. In 1919, a number of cigarette and chewing tobaccos, as the White Burley, Judy's Pride, Gooch, Adcock, White Stem Orinoco, Improved Gold Leaf, and North Carolina Warne were successfully grown (Leaño, 1919). Experiments were also conducted on the manufacture of cigarette and pipe tobacco, and the results show that there are great possibilities in the manufacture of these articles locally.

Judicious use of fertilizers, green manuring, and crop rotation resulted in a significant increase in yield of tobacco leaves (Palafox, 1916; Ramos, 1930). Tobacco worms and the occurrence of diseases were reduced to the minimum when clean culture was practiced. Under local conditions it cost about ₱200 to raise one hectare of tobacco, yielding approximately 32 piculs (Cabauatan, 1934).

VEGETABLES

Lettuce. Of 60 varieties of lettuce tested, Mignonette and Continuity were found to be the best for the heading type; Grand Rapids and New York were selected for the leaf type (Collado, 1934; Avila, 1934).

Peas. Of 115 varieties tested, the following proved to be the highest yielders: MacLean's Advancer, Prince Albert, Wilhelm I, Early Wonder, and Mai. The study showed that it was not profitable to grow peas under Los Baños conditions (Dacanay, 1916; Naron, 1934).

Tomatoes. In a variety test of American tomatoes it was shown that they were all susceptible to bacterial wilt, including the variety Marglobe which is supposed to be highly resistant to this disease. Conditions prevailing in this locality were found to be unfavorable for tomato growing, although in places where the soil was free from wilt disease and provided with good drainage varieties Stone, Earliana, Glove, and Ponderosa did well (Uichanco, 1915; Tolentino, 1934).

Onions. Of the different varieties of onions grown the Bermuda proved most at home under College conditions. The plants grew best when planted after the rainy season especially towards the cooler part of the year, about October and November (Pastorfide, 1918; San Pedro, 1934).

Peppers. Of 19 varieties of sweet peppers studied the following were recommended for planting: Bolivian, Ruby King, Harris' Early Giant, Hungarian Yellow and Red Chili (Asuncion, 1934).

Carrots. Carrots gave fair-sized roots which, when harvested at their prime were of good eating quality. The varieties that showed good response to local conditions were Chantenay and Danver's Half Long (Duque, 1934).

Sugar beets. This vegetable grows well under College conditions. The following varieties have so far proved the best: Extra Early Egyptian Blood Turnip, Early Wonder, Crosby's Egyptian, Ferry's Crosby and Early Blood Turnip Improved (Bumagat, 1934).

Cabbage. Compared with Baguio the yields obtained from cabbage were much lower and cost of production much higher.

In many tests on fertilizing vegetables practical data were obtained. By the use of Ammo-Phos at the rate of one kilogram per six square meters the yield of pechay was increased from an average of 46.78 grams per plant (without treatment) to 228.86 grams. The net gain per hectare per crop was estimated at ₱949.05 when fertilized with Ammo-Phos (Vibar, 1931).

It is of interest to note that lumbang and baguilumbang cakes proved to be good fertilizers. When used on pechay, 3 kilograms of lumbang cake proved to be more efficient than 1 kilogram of Ammo-Phos giving a saving of ₱15.24 per hectare (Gabertan, 1934).

Of the different treatments for radishes the 100 per cent nitrogen fertilizer (970.87 grams per sq. m.) gave the best yield. It increased the yield by about three times, increasing the net profit per hectare by ₱483.54 (Vera, 1933).

For tango (*Chrysanthemum coronarium* Linn.) the best combination tried was the 25–50–25 applied at the rate of 100 grams

per square meter. It increased the profits per hectare by ₱292.71 (Garcia, 1933).

In the case of lettuce the best response was obtained from 25–50–25 applied at the rate of 200 grams per square meter. The net gain was estimated at ₱1,634.48 when this combination was used; the gain was ₱760.40 when no fertilizer was applied (Espiridion, 1934).

Several methods of preserving vegetables have been studied including dehydration, pickling and canning.

Results obtained from studies in the Department seem to show that under the soil and climate conditions of the College the culture of asparagus, rhubarb, artichoke, spinach, cauliflower, Brussels sprouts, Irish potatoes, and peas, should not be attempted. Even New Zealand spinach did not do very well.

Favorable results have been obtained from the following vegetables: sitao, batao, seguidilla, lima, paayap, patola, cucumber, condol, upo, squash, chayote, pechay, lettuce, cabbage, sugar beets, and carrots. Of the garden beans, Kentucky Wonder, Canadian Wonder, and Bean Horticulture proved most at home when planted about November. Those planted earlier were in most cases attacked by nematodes during October. American cucumbers did not make a good showing. Eggplant and peppers grew very well provided the soil was free from bacterial wilt (Gonzalez, Dawis, and San Pedro. 1934).

Wild food plants. Of 106 wild food plants studied for their culinary properties 82 kinds were found suitable for table use. Of these, 60 have not been reported by earlier investigators; 33 are eaten in other countries, but not locally, and 13 are being utilized here for parts other than those studied. Only 2 species showed high concentrations of hydrocyanic acid content and 3 are doubtful. The others were not suitable for eating either because of poor flavor or fibrous texture (Pandinco, 1933).

The distance from College of Agriculture to Manila is 68 kilometers.

THE CENTER OF THE CAMPUS FROM BALONG BULO HILL

In the foreground are some of the field crops and orchards of the Experiment Station. In the center are College buildings, with the residential and commercial Coconut Grove, a village, at the right. Laguna de Bay in the distance.

A QUARTER CENTURY OF RESEARCH ACTIVITY IN THE DEPARTMENT OF PLANT PHYSIOLOGY [1]

RAFAEL B. ESPINO
Of the Department of Plant Physiology

No less than 200 papers from the Department of Plant Physiology have been published and about one-third as many have appeared in print as abstracts. Of these papers, 32 were on rice, 25 on coconut, 28 on abaca and other fiber plants, 6 on sugar cane, 5 on cotton, 4 on banana, 4 on weeds, 8 on fruit trees, 10 on saponin, tannin and poison-bearing plants, and the rest on miscellaneous topics, all relating to plants;—this list does not include the extensive work and voluminous publications on ferns. Of these more than 200 studies, 40 papers were on salt and fertilizer requirements of plants of certain economic value, 33 papers on morphology and anatomy, 12 papers on water requirement—to cite only a few lines to illustrate the nature of the research work of the Department.

STUDIES ON CLASSIFICATION

The ferns of the Philippines have been well classified; also the varieties of banana. Attempts have been made to study varieties of abaca, coconut, cultivated beans, cassava and the root crops. Weed seeds also have been studied.

ECOLOGICAL AND ACCLIMATIZATION STUDIES

The effects upon vegetation of the eruption of Taal Volcano and the revegetation of its locality were observed. The swamp vegetation in the hot spring areas in Los Baños, Laguna was studied. The weeds in the rice fields and their effects on rice production were likewise studied. In this work on the rice field, it was found that there were in the caiñgin fields 15 families, 82 species, and 468 individuals of weeds. The dominant species of weeds in the caiñgin fields, in the order of their abundance, are *Synedrella nodiflora, Mimosa pudica, Imperata cylindrica, Saccharum spontaneum,* and *Paspalum conjugatum.* The weeds in the upland fields, in the order of their abundance, are *Amaranthus spinosus, Synedrella nodiflora, Malachra capitata, Eclipta alba,* and *Paspalum conjugatum.* In the low-

[1] General contribution from the College of Agriculture No. 418.

land fields there are, in the order of their abundance, *Panicum crus-galli, Cyperus difformis, Monochoria vaginalis, Fimbrystilis camplanata*, and *Synedrella nodiflora*.

It was found that the number of weedings influenced materially the yield of rice. Calculated on the basis of one hectare, the yields of rice as influenced by weeding were as follows:

WEEDINGS	CAIÑGIN	UPLAND	LOWLAND
	cavans	*cavans*	*cavans*
Five weedings	26.34	30.00	44.00
One weeding	15.17	20.02	36.35
No weeding	10.67	18.00	32.50

Studies on acclimatization of raspberries at different stations on Mount Maquiling and in southern Tayabas were made and some encouraging results obtained. Also, the recuperative growths within a year of some plants injured by a typhoon were observed and a simple device used in lifting the fallen trees to normal position was described.

MORPHOLOGICAL AND ANATOMICAL STUDIES

Contributions to knowledge of the morphology and anatomy of plants have been numerous. Only a few of them, however, may be cited here. The floral morphology of *Musa errans* (Blanco) Teodoro var. *botoan* Teodoro was studied. It was found that nearly all or all of the stamens aborted in the female and neuter flowers, while the pistil degenerated. It was also found that usually one of the stamens aborted in the male flower. The zygote remained dormant long after fertilization but ultimately gave rise to an embryo in the mature seed. It was further found that pollination was necessary for the proper development of the fruit of *botoan*.

The floral morphology of the mango (*Mangifera indica* Linn.) was also studied. It was found, among other things, that the inflorescence of the Pico mango has numerous polygamous flowers. In the staminate flower, the pistil becomes abortive, usually only one of the stamens becomes functional, and occasionally two or three stamens produced pollen grains. It was also found that after fertilization, the zygote remains dormant for some time. Later, however, it gives rise to an embryo. In this study, a zygote was once found to be degenerating and adventitious embryos were found to be developing from nucellar cells. The floral structures of the strawberry mango, an Indian variety, were also studied. It was found that all the embryos arise from the nucellus. The egg, after

fertilization, remains alive for a long time in the embryo-sac, but it ultimately degenerates. For these reasons, it was deduced that this mango variety is not a suitable material in hybridization work.

The cause of the sterility of *Spondias* was determined microscopically and otherwise. It was found to be due to the absence of seed in the mature stone, which, in turn, was due to the degeneration of the microspore mother-cells, although the megagametophyte was found to be normal.

A case of sterility in a full-grown santol tree was studied, and it was found that the sterility was due to the lack of pollination. There was no pollination because the sepals and petals of the flower remained closed. Moreover, microscopical study showed that the microspores were hermetically sealed in the anthers and that they degenerated either before or after the flower fell to the ground.

In the study of the laticiferous vessels in the Para rubber tree (*Hevea brasiliensis* (HBK) Muell-Arg.) microscopic sections were examined. It was found that latex vessels are present in young stems, in the leaves, and also in the roots. None, however, was found in the secondary wood, except the medullary rays, but they are abundant in the inner and outer bast,—apparently originating from two places in the mature bark, one from the secondary cortex and the other from the primary cortex and phellogen.

Anatomical studies of the abaca plant and its fibers were also made. It was found, among other things, that the width of the leaf sheaths of a false trunk increases from the outermost to one-third or one-half of the way to the middle; thence inward the width decreases. It was also found that the yield of fiber varies with the width of the leaf sheath. The outer sheaths produce coarse and often discolored fiber suitable for cordage; but the fiber from the inner sheaths is finer and weaker, and better adapted for textile manufacture. The strongest fiber is from the widest leaf sheath, and the fiber from the edges of a leaf sheath is finer and about ten times stronger, per unit of weight, than that from the middle part of the same leaf sheath.

Fifty-four varieties of abacá grown side by side in Los Baños were studied microscopically and otherwise. It was found that Boñgulanon, Libuton, Sinaba, Agogaron, Layahon, Pagoonayan, Putian, Alman, and Sinantacruz produced comparatively coarse fibers. Of the 54 varieties, Ilayas has the longest fiber cells and Agutay, the shortest. The Boñgulanon, Sinaba, Punucan, Pulahan, Visaya, Lagurhuan-burawen, Baguisanon, and Lono produce fiber cells with comparatively thick walls. However, owing to certain discrepancies in

the data obtained, further studies on dimensions of the fiber elements should be made. In tensile strength of fiber, however, it was definitely established that of these 54 varieties and in term of number of fiber strands, the following varieties produce relatively strong fibers: Boñgulanon, Visaya, Sinaba, Sugmod, Tañgoñgon, Punucan, Maguindanao, Itom and Linawaan. Those found possessing relatively weak fibers were Pacol, Poñgay, Laguis, Lagurhuan-dogami, Bulao, Sabaon and Layahon-ñga-busag. However, in term of one gram weight of the sample, the fibers of Sinaba, Punucan, Linawaan, Libuton and Maguindanao were found to be relatively strong. It was interesting to note that the tensile strength of the fibers was not

Fig. 1.—Students of plant physiology measuring the rate of growth of corn plants. They are trying to determine if there is any correlation between rate of growth of the plant and its productivity.

always correlated with the physical characters of the fiber cells; this was true in all 54 varieties.

Further microscopic studies on fibers revealed the fact that most of the buntal fibers in the market were vascular bundles, but purely sclerenchyma strands were also present. The fibers obtained from the central portion of a petiole of the buri palm (*Corypha elata* Roxb.) were relatively coarse and, in term of one gram weight of the sample, weaker than the finer fibers found near or along the outer epidermis of the same petiole. It was, therefore, suggested that the fibers obtained from near or along the outer epidermis should be separated from those from the central portion of the petiole, and be sold as a special fiber. The fiber from the fourth petiole

is the strongest; thence, the strength decreases gradually outward and inward, to the oldest leaf and to the youngest visible petiole, respectively. This finding seems to indicate that the proper rate of harvest should be the first four petioles; and one petiole a month thereafter.

Among the results obtained from the study of other fibers and fiber-bearing plants, the following data may be of interest:

FIBER PLANTS	WT. OF LEAF OF AV. SIZE	AV. YIELD OF FIBER PER LEAF	AV. DIAMETER OF FIBER	TENSILE STRENGTH OF FIBER SAMPLE	
				Maximum	Reduced to one gram sample
	grams	*grams*	*cm.*	*kgm.*	*kgm.*
Maguey	542	30.0	0.195	4.91	112.9
Zapupe	585	17.2	.242	4.96	115.3
Sisal	748	23.4	.306	6.88	109.7
Mauritius hemp	1,371	11.7	.199	3.89	105.1

GERMINATION OF SEEDS

It was experimentally found that for seed dead-ripe coconuts were superior to those at any other stage of ripeness. Partial or complete husking is undesirable as the shell cracks quite easily when the nut is husked. The best position for placing the nuts in the seed bed, it was found, is on the *side*. And, because the meat content is still plentiful, the root short, and the shoot also short, the best time to transplant a seedling is when the shoot is from 15 to 30 cm. high.

With rice, the highest percentage of rapid and uniform germination was obtained when the seeds were soaked in water for two days and planted two days later. A higher percentage of germination was obtained when the seeds were sown in soil *saturated* with water than in *under-saturated* or *over-saturated soil.* A delay, even of three days, in sowing the seeds after soaking resulted in poor germination.

From the study of the germination of abacá seeds, it was learned, among other things, that under ordinary conditions of the soil and climate, seeds begin to sprout in from 11 to 24 days. Some of the seeds, however, require 100 days and one extreme case 155 days. Drying the seeds in the sun for 24, 48 or 72 hours resulted in a loss of vitality. A higher percentage of germination was obtained from the seeds planted immediately after removal from the fruit pulp than from those dried in the shade for 24 hours before planting. Soaking in warm water or in inorganic acids did not produce

better germination. All the seeds fed to chickens were digested; and, although not digested, the seeds that had passed through the alimentary system of monkeys gave a low percentage of germination. When fed to man, however, the highest percentage of germination within a short time was obtained.

Sand was a better germination medium for all the vegetable seeds studied than garden loam soil. In sand, 80 to 90 per cent water saturation was the best for the seeds of pechay, lettuce, cabbage, radish, pepper, eggplant, and tomato; 90 to 100 per cent water saturation was the best for beets and mustard seeds. In garden loam soil, also, 80 to 90 per cent water saturation was the best for pechay, lettuce, tomato and eggplant, but for beet seeds, the best result was from 90 to 100 per cent saturation.

The weed seeds studied failed to germinate in sand containing moisture as low as, or lower than, 30 per cent water saturation. Seeds of *Panicum crusgalli* did well at water saturation ranging from 80 per cent to supersaturated condition; 90 per cent being the optimum. The best germination records of seeds of *Cyperus iria, C. difformis, C. pilosus, Fimbrystilis annua* and *Eclipta alba* were obtained in pots containing submerged soil. With the exception of *C. pilosus,* and *E. alba,* the other weed plants showed resistance to the presence of much water in the soil, but at the depths of 5 or 10 cm. of water in pots, these two species died. Young plants of *Panicum crusgalli* died when submerged for 36 days in water 15 cm. in depth. The other weeds remained alive even when submerged in water for 68 or more days.

WATER REQUIREMENTS

If the number of requests for data on water requirements of plants can be taken as an indication of importance, this phase of study may be considered as quite important. Several such requests were received from farmers and irrigation engineers and the data furnished by department experiments showed that when grown in clay loam soil in pots, 70 to 90 per cent water saturation [2] gave excellent growth of upland rice, variety Kinandang-pute. With 60 per cent water saturation or lower, poorly developed plants were produced; 90 and 80 per cent saturation promoted an early ripening of grain. Rice plants in pots, 30 to 40 days old, deprived of sufficient water for 15 days or less, when again supplied produced more vigorous plants and greater yield of straw and grain than plants

[2] Soil saturated with water was arbitrarily considered as *100 per cent saturation.*

supplied with water continuously. With a lowland rice, variety Macan-pina, the maximum yield per unit area was obtained from the field plots containing water 20 cm. in depth. Running water 10 cm. deep also gave excellent results for this variety, but with running water 3 cm. deep the yield was very poor.

Water requirements of sugar cane was studied also. It was found that 60 and 70 per cent water saturation of the clay loam soil in pots gave the best growth and development of the young plant; every plant of these two cultures produced suckers; 80 per cent saturation was also fairly good. The 10, 20, and 100 per cent saturations soon killed the young plants, and the 30, 40, 50, and 90 per cent saturations may be considered as also unsatisfactory.

Temporarily withholding the supply of water from the soil in pots showed certain effects upon sugar cane plant, variety Luzon White. It was found that the plants in the fertilized culture wilted earlier than those in the corresponding non-fertilized cultures, but the former recovered earlier from wilting. Wilting because of lack of water in pots was more harmful to the younger plants than to the older. It was not possible to determine if continuous or regular watering from the time of planting to maturity was always the best for the plant. However, the plants continuously supplied with water from the time they were 160, 175, or 178 days old grew better and gave higher yields of top and root than those the water supply of which was withheld earlier, that is, when the plants were less than 122 days of age.

Moisture contents of soil ranging from 40 to 60 per cent saturation were found to be good for corn. For the best growth and yield of the cotton plant, a rather wide range of moisture content of the soil was needed. For the wet season planting, 30 per cent water saturation was the best; for the dry season planting, 50 per cent.

The best growth and development of young abacá plants was obtained from pots supplied with 60 to 80 per cent water saturation; the plant could not be grown well even in fertile soil when the moisture content was less than 50 per cent saturation. The optimum water requirement of the plant when grown in clay loam soil probably lies somewhere between 60 and 80 per cent saturation, or 70 per cent.

PHOTOSYNTHESIS AND INFLUENCE OF LIGHT ON GROWTH

It was found that the rate of photosynthesis, or manufacture of carbohydrate by the sugar cane plant decreased from 10 a. m. to

4 p. m.; that is, more active in the morning than in the afternoon; and the highest rate occurred from 8 to 10 a. m. The most active manufacture of food occurred in young leaves, and the process decreased as the leaves became older.

With rice, however, it was found that with equal surface area, the middle-aged leaves absorbed carbon dioxide faster than either the oldest or the youngest leaves of the middle-aged plants.

Direct sunlight was far more effective in promoting production of dry matter in certain plants than diffused light. The *cucharitas* and *alicbañgon* throve almost as well under diffused light as under direct sunlight. Rice, maize and pechay, however, were decidedly benefited by direct sunlight. The morning sunlight was far more beneficial than the afternoon sunlight to these five plants, particularly to rice, maize and *cucharitas*.

SALTS AND FERTILIZER REQUIREMENTS

Extensive studies on salt requirements of young rice plants revealed that the plant could not grow well in any complete culture solution in which nitrogen was present only as a nitrate. But, when ammonium and nitrate were present at the same time, normal growth and development was obtained. The question then came up as to whether or not nitrate was needed at all by the plant. To find this out, further experiments were conducted, and it was found that nitrate was essential for the normal development of the plant; its absence in the solution always produced a characteristic injury—drying of older leaves and leaf tips. Of all the ammonium salts tested, NH_4NO_3 was the best; $(NH_4)_2SO_4$ was next best; and $NH_4H_2PO_4$ the poorest, as it always caused drying of leaf tips of rice plants. NH_4Cl was also found to be good.

It was also revealed that the young rice plant was very tolerant to, indeed preferred, a relatively large amount of $MgSO_4$ in the culture medium, and that the apparently beneficial effect was due not to the increase of Mg-ion or of SO_4-ion, but to the increase of $MgSO_4$ itself. Of all the magnesium salts tried, $Mg(NO_3)_2$ and $MgH_4(PO_4)_2.H_2O$ when used in rather large amounts, always produced plants with leaves chlorotic and dried at tips; $MgSO_4$ was not toxic to young rice plants.

In complete culture solutions, nitrate salts showed different effects upon young rice plants. Nitrates of alkali and alkaline metals were beneficial. Also the NH_4NO_3 and $Mg(NO_3)_2$ were good. But, $Co(NO_3)_2$, $Cu(NO_3)_2$ and $Ni(NO_3)_2$ killed the plants, and $Pb(NO_3)_2$

and $Zn(NO_3)_2$ produced chlorotic plants stunted in growth. $Al(NO_3)_2$ and $Cr(NO_3)_2$ produced slender plants, but $NaNO_2$ was fairly good.

In complete culture solutions, a range of from 13.3 to 133.4 p.p.m. or more of ferric chloride and of ferric nitrate was good for rice. But the minimum beneficial amount of ferric phosphate was 33.4 p.p.m. A small amount of each of potassium ferricyanide (1.65 p.p.m.), ammonium ferric sulfate (0.99 p.p.m.), and ferrous sulfate (1.32 p.p.m.) was sufficient to produce green plants.

For young rice plants and at concentration 0.00025, 0.0005 or 0.00075 gram-molecule, both $Al(NO_3)_3$ and $Al_2(SO_4)_3$ were more harmful when added to *poor* culture solutions than when added to

Fig. 2.—Rice plants of the same variety were grown in clay-loam soil in pots containing moisture of different amounts. Note the different heights and sizes of the plants as influenced by the amount of moisture in the soil.

good culture solutions. The addition of a moderate amount of NaCl to a 4-salt solution previously found as "best" for rice, materially improved the nutritive value of the solution; the beneficial effects were derived from the Cl-ion, not from the Na-ion.

Commercial fertilizer tests showed that rice plants supplied with sulfate of ammonia produced dark green leaves. As the fertilizer was increased, the chlorophyll and the moisture content of the leaves also increased. A decrease of ash content, however, was noted. A moderate application of ammonium sulfate tended to promote root production, but when used in larger amounts, root development was retarded, especially in mature plants. The fertilized plants produced

more but shorter roots than the unfertilized plants. The optimal amounts of ammonium sulfate for rice plants grown to maturity in pots ranged from 5.43 to 13.91 grams per 625 sq. cm. of soil surface. But, when supplied with 43.5 grams of the fertilizer, the plants produced large tops and strikingly small root systems.

Turning under weed plants and allowing them to rot in the soil before planting lowland rice was beneficial to grain and straw production. But, when only the roots of the weeds were allowed to rot in the soil, a decrease in yield of grain and of straw resulted. A complete removal of the weeds resulted in a material decrease in yield of grain. It was also observed that the presence of rice straw, rice straw ash, or both straw and ash in clay loam soil in pots was harmful to the growth and development of young rice plants. The harmful effects were severe when only rice straw was added to the soil and increased with the amounts of straw used. But, when allowed to decompose in the soil for more than 75 days before planting, the straw not only had no harmful effects, it even proved nutritive or stimulating to young rice plants.

Salt and fertilizer studies with sugar cane were also made. As did rice, sugar cane did well in culture solutions with extremely low concentrations,—0.001 or 0.002 gram-molecule (of all the salts taken together) per liter. As did rice, sugar cane did well also in culture solutions in which nitrogen was present as NH_4-ion and as NO_3-ion, but unlike rice, it could be grown successfully when nitrogen was present only as NO_3. When nitrogen was present only as NH_4, young sugar cane plants with dried leaves and dried leaf tips were produced, showing similar effect as on young rice plant. When grown in clay loam soil in pots, sugar cane plant did well when supplied with 15 parts N, 5.5 parts P, and 1 part K.

Sugar cane bagasse when added to clay loam soil in pots was harmful to young sugar cane plants. The detrimental effects were almost proportional to the amounts of the bagasse used. Bagasse ash added to pots failed to counteract the harmful effects of the bagasse. But when bagasse ash, alone, was added to the soil, the growth of the plant was improved. The harmful effects of the bagasse diminished with the degree of decomposition, and when nitrogenous fertilizers, especially ammonium sulfate, were added.

Salt and fertilizer studies with the coco palms were also made. Of the culture solutions tried, the one which was most readily absorbed by the roots of the palm contained 1 part each of $(NH_4)_2SO_4$, KH_2PO_4 and $Ca(NO_3)_2$, and 5 parts of $MgSO_4$ with a total concentration of 0.1536 gram-molecule (of all the salts taken together)

per liter. The rate of intake of this solution by the roots of the palm was considerably increased upon addition of 1 per cent molar solution of NaCl. A heavier application of NaCl caused a decrease in the rate of absorption. It was estimated that the roots of a two-year old coco-palm could absorb as much as 150 to 275 grams of the culture solution in one day. It was also estimated that a full grown coconut tree could absorb about 16 liters of a culture solution in one day; but when a solution of KNO_3 alone, was used, the estimated absorption was higher, 24 liters.

Using commercial fertilizers, it was found that the most rapid growth of transplanted coconut seedlings during the first three months was obtained from the application of 131.6 grams of sulfate of ammonia. Seedlings given nitrate of soda at the rate of 500 grams per tree did not do well. From another study it was found that at the rate of 155.7 grams per seedling, sulfate of ammonia gave good results, but, at the rate of 458 grams, this fertilizer was decidedly harmful to the plant. Of the different amounts of Corona Cocos tried, 229, 458, and 916 grams per seedling were the best. Ammo-Phos 13–48 at the rate of 84 grams per plant produced seedlings with well developed tops and roots, but when the application was increased to 458 grams, no beneficial effect was obtained. Ammo-Phos 20–20 when used at the rate of 457.7 grams per plant was good for coconut seedlings. A mixture of 51.9 grams sulfate of ammonia, 884.8 grams horse manure, and 113.7 grams superphosphate gave the best results and the combined N-P_2O_5-K_2O contents of the fertilizing mixture and the soil used, in grams, were 44.0-123.3-130.3, respectively. The effect of a mixture of 142.9 grams of nitrate of potash and 1,329.3 grams horse manure was good growth and development of young coconut plants.

A culture solution containing KH_2PO_4, $Ca(NO_3)_2$ and $MgSO_4$ was absorbed by an abacá plant at the rate of 0.23 kgm. a day. On computation, the roots of one clump of abacá plants could absorb about 2.4 kgm. of the solution in one day. When grown in clay loam soil in pots, the best growth and development of the young abacá plants was obtained from the cultures that received a moderate application of either sulfate of potash or double superphosphate and a relatively heavy application of sulfate of ammonia. The sulfate of ammonia was two to three times as much as either of the other two fertilizers.

Young cotton plants grew well when supplied with 25 grams dried blood, 5 grams double superphosphate, and 8 grams sulfate

of potash. High yields of seed cotton were obtained from cultures liberally supplied with sulfate of ammonia. These yields were about seven times as much as those obtained from the unfertilized cultures.

High yields of tobacco leaves were obtained from tuff soil to which were added a relatively high or medium amount of sulfate of potash and double superphosphate and a relatively low amount of sulfate of ammonia. On the other hand, low yields of leaves were obtained from the cultures that were supplied with relatively low amounts of either sulfate of potash or double superphosphate and a relatively high amount of sulfate of ammonia. The leaves from the *good* cultures produced cigars that burned rather slowly, while those from the *poor* cultures burned rather fast.

Effects of fertilizers on the growth and development of young lanzon plants (*Lansium domesticum* Correa) were for the first time observed at the College. It was found that of the cultures supplied with Corona Cocos, that which received 35.2 grams of the fertilizer in tuff soil grew the best, although only about 98 per cent better than the unfertilized culture, and, not any better than the *poorest* culture supplied with Ammo-Phos 13–48. Of the cultures supplied with Ammo-Phos 13–48 the vigor of the best plant was improved 650 per cent compared with the unfertilized plant. This "best" culture received 57.2 grams of Ammo-Phos 13–48 in two applications and, together with the fertilizer ingredients originally present in the soil, supplied the plant with 12.7 grams N, 49.1 grams P_2O_5, and 25.2 grams K_2O. The best culture which was fertilized with 1.49 gram N from sulfate of ammonia was only 115 per cent better than the control culture. But, when 13.2 grams sulfate of ammonia, 13.5 grams superphosphate and 30 grams air-dry horse manure were mixed and added to the soil in pots, the vigor of the lanzon plant was 338 per cent better than that of the control culture.

SOME OTHER STUDIES

Other studies, such as, transpiring power of the leaves of abacá and coconut; rates of growth of certain plants, permeability of *Citrus* leaves to water and the amount of pressure to cause stomatal infections with the citrus canker organism; rates of ascent of sap in plants; leaf fall under tropical conditions; leaf crystals; parasitism of certain phanerogamic parasites; effects of anaesthesia on *Mimosa pudica;* pre-determination of sex in papaya; yields of cotton, coconut, and other plants, origin of the odor in poñgapong, *Amorphophalus campanulatus;* time of opening and closing of flowers; poison, tannin, and saponin containing plants, have also been studied. But the results obtained from these studies will not here be considered.

It should, however, be mentioned that the *heavy clay loam* soil, the *light gravelly loam*, and the *sand* when separately planted to cowpea plants, *Vigna sinensis* (Linn.) Savi ex Hassk, produced nodules with relatively low nitrogen contents. The Lipa clay loam and its *subsoil* caused the production of root tubercles of cowpea with relatively high introgen content. Sterilization of Lipa clay loam soil by heat, whether partial or thorough, was harmful to nodule production and the fixation of nitrogen in the nodules. The nodules of the plants grown on the unsterilized soil produced 0.0349 gram of N; while the nodules from similar plants grown on the sterilized soil contained only 0.0046 gram of N. As many as 403 nodules with a dry weight of 0.663 gram was produced in the unsterilized culture; while the best result obtained from a similar but sterilized culture was only 76 nodules having a dry weight of 0.101 gram. In the bay loam soil the cowpea plant could not grow; soon after germination, the plants died.

The addition of horse manure to Lipa clay loam soil was beneficial not only to the growth of the cowpea plant but also to the production of nodules and of total nitrogen in the nodules. But, the addition of ammonium sulfate to the subsoil of Lipa clay loam produced nodules containing less nitrogen than those from the control (subsoil only), and less than those that received either potassium sulfate or superphosphate.

There are approximately 1,514 living species of cultivated and wild plants, excluding algae fungi liverworts and mosses, on the College of Agriculture Grounds. They represent 819 genera and 153 families. Undoubtedly, there are many unidentified. A large percentage of the known species are fairly represented in the College Herbarium.

Of the flora of Mount Maquiling, the Division of Forest Studies and Research, Bureau of Forestry, have listed 1,238 arborescent species, not including herbaceous and lower plants. These species represent 473 genera and 121 families.

Only under a slogan of "buying only such things as we can pay for" can we look forward to rounding the points in the curves of our economic cycle. Pyramids of credit crumble under the least breeze of economic change.—KARL B. MUSSER.

BAKER MEMORIAL HALL

Named in memory of the second Dean of our College, the late Charles Fuller Baker, this Hall, although not finished, serves as auditorium, gymnasium and armory.

A TWENTY-FIVE YEAR BALANCE SHEET FOR ECONOMIC ENTOMOLOGY [1]

LEOPOLDO B. UICHANCO
Of the Department of Entomology

Orientation. By way of establishing our bearings preparatory to undertaking specialized research, it became apparent at the inception of the work of the Department that a survey of Philippine insects that affect, not only cultivated plants, but also wild hosts, was necessary. Cevallos (1911a) and Navarro (1911) gave general accounts, with random observational notes, on some economic insects found on the College campus. Uichanco (1915) included, in an agronomical paper on tomato, notes on ten insect species attacking this plant. These papers were followed by Edrozo (1918) on tobacco worms, of which he recognized five species. A more extensive treatment was made by Woodworth (1921, 1922a, 1922b) when he, mainly with the help of students who took the introductory courses in entomology, published his host indices of insects injurious to Philippine crops. This series of three papers gives an enumeration of Philippine insects known to affect ninety-one species of economic plants and also stored products. As work progressed and further data accumulated, more inclusive lists were prepared for sugar cane (Uichanco, 1928), for rice (Uichanco, 1929), and for coconuts (Uichanco, 1930). The records of breeding work in the Department's insectary cover some one thousand accessioned and numerous unaccessioned items. Pending their eventual rearrangement and publication as a whole, these records have proved useful to us and to other workers in connection with data on occurrence of insect pest species in the Philippines, as well as their host relationships. Copeland (1924) in his book on rice, Dammerman (1929) in his "Agricultural Zoölogy of the Malay Archipelago", and Hunter and Uichanco (1932) in "New Civic Biology" drew mainly from these unpublished data for material on Philippine insects that affect agricultural crops.

In addition, such subjects as plant galls (Uichanco, 1919), which, although without immediate practical application, are of some

[1] General contribution from the College of Agriculture, No. 419.

interest from the standpoint of insect biology, were taken up in these surveys.

An account purporting to give a history of entomological work at the College of Agriculture, and, for that matter, in the Philippines, would not be complete if at least a passing mention of the late Dean Charles Fuller Baker's entomological activities were omitted. Although done outside of office hours and at personal expense, his extensive insect collection, the coöperation of over 115 world authorities on various insect groups he was able to enlist in working out his material, the over 400 published papers that resulted, and the availability for consultation in Dean Baker's residence of his determined material, for fifteen years released the already undermanned Department from taxonomic work for the equally important activities in economic entomology. Moreover, his furious zeal, backed by a quarter of a century of previous fruitful experience along entomological lines in various parts of the world, gave this Department its first breath of research life.

Biological studies on agricultural insect pests. More or less detailed biological studies, with a view to control, have been made on *Agromyza phaseoli* Coq. (= *A. destructor* Malloch) (Otanes, 1918), *Leptocorisa acuta* Thunberg (Uichanco, 1920), *Heterographis bengalella* Rag. (Estalilla, abstract by Cendaña, 1921), *Cosmopolites sordidus* Germar (Cendaña, 1922), flea beetles (Reveche, 1922), *Amorphoidea lata* Motschulsky (Woodworth, 1922), *Schoenobius incertellus* Walker (Rowan, 1923), *Tetraneura hirsuta* (A. C. Baker) (Tan, 1924), *Prays citri* Milliére (Mañalac San Juan, 1924), *Cylas formicarius* Fabricius (Gonzales, 1925), *Olethreutes schistaceana* Snellen (Uichanco, 1927), *Perkinsiella vastatrix* Breddin (Urbino, 1927), *Pyrausta nubilalis* Hübner (Buligan, 1929), *Leucopholis irrorata* Chevrolat (Uichanco, 1930, 1931), *Trionymus sacchari* (Cockerell) (Uichanco and Villanueva, 1932), insects on stored corn (Uichanco and Capco, 1933), and *Ceratia similis* Olivier (Madrid, 1934a).

Biotic potential. Some idea of the biotic potential of Philippine insects may be gained by applying Chapman's formula to examples deduced from the results of breeding work in our laboratory. A pair of adults of each of the five of our common pest species listed below, if all the offspring were to survive, would at the end of one year's time have the following living descendants:

SPECIES	CALCULATED SEX RATIO	MAXIMUM OFFSPRING TO A MOTHER	BROODS IN ONE YEAR	THEORETICAL LIVING DESCENDANTS
		number	*number*	*number, to four figures*
Trionymus sacchari	0.91	593	9.1	3,985,000,000, 000,000,000, 000,000,000 +
Pyrausta nubilalis	0.50	1,193	8.1	8,332,000,000, 000,000,000, 000,000 +
Cylas formicarius	0.50	340	7.2	1,685,000,000, 000,000,000 +
Leptocorisa acuta	0.50	334	7.0	46,370,000,000, 000,000 +
Ceratia similis	0.50	1,359	3.4	55,840,000,000 +

These figures show that if it were not for the natural checks offered by the environment agriculture would have been reduced to an impossible occupation by the progeny from a single pair of insect pests alone. So devastating, indeed, is the action of environmental resistance that ordinarily, among insects in the open, perhaps only a small fraction of one per cent of the total number of young produced by a mother ever succeeds in reaching the adult stage. Nevertheless, in view of the great procreative power in insects, outbreaks of certain pests do often occur.

Periodic fluctuations in insect abundance. Two types of fluctuations are recognized in the Philippines: (1) seasonal fluctuations during the year and (2) fluctuations over periods covering a series of years.

Of the first type, some of the species studied in detail showed well-marked low and high numerical levels at definite periods within the year. During the dry season, scales on Citrus become numerous (Woodworth, 1922), and our general field observations indicate that other species of scales, certain mealy bugs, like *Ferrisia virgata* Cockerell (Uichanco and Villanueva, 1932), and aphids, like *Tetraneura hirsuta,* exhibit a like peculiarity. Other phytophagous species that appear to be especially destructive during the dry season are flea beetles (generally in December and January) and *Agromyza phaseoli* (January to April). By contrast, such forms as *Leptocorisa acuta* (November and December) and *Perkinsiella vastatrix* (November) attain their numerical peak in Los Baños toward the latter part of the rainy season. These species have relatively short life cycles, which enable them to go through several broods during the year, so that their abundance during these months can

only be interpreted as due to a temporary weakening in certain uncongenial factors in the environment. Among scale insects and mealy bugs, for instance, entomogenous fungi, like *Aspergillus parasiticus* Speare on *Trionymus sacchari*, and *Aschersonia sclerotioides* P. Henn., *Microcera coccophili* Desm., *M. aurantiicola* Petch, and *Myriangium duriaei* Mont. on Citrus scales, affect their hosts

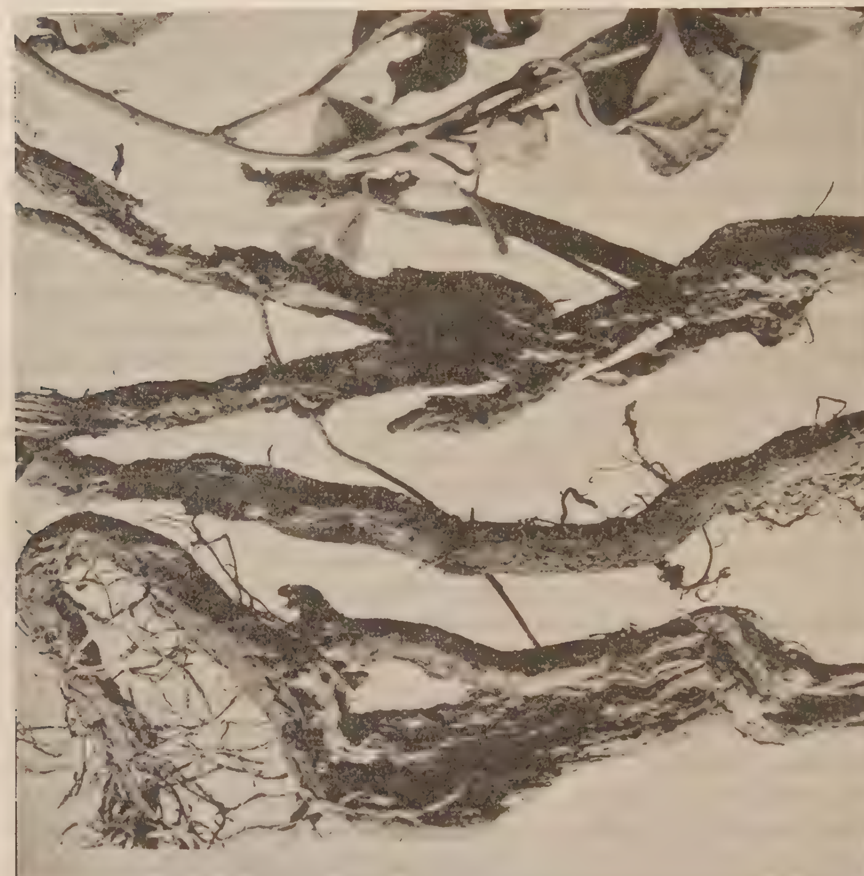


Fig. 1.—Roots of a common weed, *Ipomoea triloba* Linn., showing work of the destructive sweet-potato weevil. This weed, which grows and propagates itself throughout the year, tides the pest over lean months, when sweet potato is not in season.

disastrously during the wet season, especially toward its close, and do not relent in their stranglehold until the coming of the dry months. On the other hand, it is during the dry season that insects, like *Perkinsiella vastatrix* and *Schoenobius incertellus*, are almost nowhere to be found in their active stages. *Schoenobius* apparently

becomes dormant as pupae in rice stubble, not to emerge as adults until the onset of the rains. It is suspected that *Perkinsiella*, likewise, goes through a period of aestivation.

An interesting case was found in two closely related species of armyworms, *Spodoptera mauritia* Boisduval and *Cirphis loreyi* Dup. These two species are potentially serious enemies of both rice and sugar cane. However, nearly everywhere in the Philippines, *Spodoptera mauritia* is a real pest of rice only and *Cirphis loreyi*, of sugar cane (Uichanco, 1928). The reason is that outbreaks of *Cirphis loreyi* usually appear at about the latter part of the dry season, when late-planted canes are in a susceptible state, but rice-planting has not been begun while *Spodoptera mauritia* habitually come as armyworms early in the rainy season, when the leaves of all the canes in the field are too tough for the caterpillars to chew and rice at this time is usually young and tender.

A general analysis of the factors that influence fluctuations in numerical levels of Philippine insects was published by Uichanco (1926). The seasonal fluctuations observed in our biological studies of such serious pests as *Schoenobius incertellus*, *Spodoptera mauritia*, *Cirphis loreyi*, *Agromyza phaseoli*, and *Leptocorisa acuta*, have practical control possibilities, as has been convincingly demonstrated in Java in connection with *Scirpophaga innonata* (Van der Goot, 1930).

Fluctuations in insect abundance over periods covering a series of years have been noted in several species of insects, notably in *Locusta migratoria* Linn. The same characteristic is apparently exhibited by *Promecotheca cumingi* Baly (Uichanco, 1930, 1931). An analysis of the factors involved in this phenomenon has been undertaken by our laboratory, but awaits further completion of data prior to publication.

Weeds and insect pests. Illustrations of the important bearing of weeds on insect pests are furnished by the results, not only of our detailed biological work, but also of our general breeding of phytophagous insects, where a large majority of the insect pests are found to be oligophagous, with weeds among their alternative hosts. Even such an insect as *Cylas formicarius*, which at the publication of Gonzales' (1925) paper had been taken as monophagous on camote, was subsequently found to breed also in the roots of a common congeneric weed, *Ipomoea triloba* Linn. Fruits of nangca (*Artocarpus integrifolia* Linn.) and of ates (*Anona squamosa* Linn.), when raised on the outskirts of forests, such as on the College farms, are severely damaged by *Bactrocera umbrosa*

Fabr. and *Heterographis bengalella* Rag., respectively, while in thickly settled districts, such as Manila and its suburbs, these pests are relatively unimportant, the natural inference being that both species normally breed on certain wild forest fruits.

In addition to furnishing alternative hosts, weediness encourages armyworm destructiveness to rice and sugar cane, inasmuch as it delays hardening of the leaves (Uichanco, 1928).

White grubs. Like most other members of the large family Scarabaeidae, these insects are remarkable in that they are among the comparatively few species of Philippine insects that exhibit a long life cycle. In *Leucopholis irrorata* Chevrolat the average life cycle was found to be 339.41 days (Uichanco, 1931). Because of the destructiveness of this pest, especially to sugar cane, it has received a great deal of attention among local workers. As a result of investigations in this Department (Uichanco, 1930), certain conclusions were arrived at pointing to the apparent fallacy of the current methods of control by collecting the beetles, on the ground that, not only is a relatively small proportion of this potential source of infestation caught, but also only about 20 to 30 per cent of the adults found in the open are females, and, of these, less than 30 per cent are gravid, the rest being spent. Moreover, the average egg content of each female is very low, or only 3.11 to 5.2, in spite of the fact that other investigators elsewhere have, with rare mathematical ingenuity, inflated the quotient to several times as many by the convenient process of disfranchising in the divisor the eggless females, which constitute some 70 per cent of this sex in a lot.

The method principally advocated by us is to take advantage of the selective habits of the adults in chosing oviposition sites, which are apparently limited to very restricted foci in a habitually infested field. The grubs hatching from the eggs apparently remain in their original location and do not spread out to the rest of the field until after they reach the third instar, about 140 days later, when they first disclose their presence by the dying of canes in small patches. This earliest sign of infestation appears to be a critical point in control, when the grubs may be easily and cheaply kept from dispersing by a shallow trench into which a 1: 5 dilution of coal tar-kerosene emulsion is poured. The third-instar larvæ, thus crowded, are very pugnacious and fight each other to death or are decimated by outbreaks of the common entomogenous fungus, *Cordyceps podocreoides* Von Höhnel. Failure to recognize this peculiar phenomenon in the biology of *Leucopholis irrorata* has led to unnecessarily expensive control practices in the past.

Natural enemies of agricultural pests. A summary of the known parasitic enemies of agricultural pests in the Philippines, largely from the results of our breeding work and in part from published records, was read in a paper at the Second Philippine Science Convention in Manila (Uichanco, 1933). This summary consisted of: (a) Parasitic Hymenoptera, 171 species, of which the Chalcidoidea was represented by some 44 per cent of the total; (b) Diptera, mostly Tachinidæ, 20 species; and (c) entomogenous fungi, 31 species.

The primary objective in a survey of autochthonous natural enemies is that, besides the fact that we thereby gain a more precise evaluation of this important factor in environmental resistance, an intelligent basis may be found for any importation of exotic beneficial species. Already, steps in this type of importation have been undertaken to a very limited extent in this country. A species of mynah birds, the British Indian mynah, *Acridotheres tristis* (Linnaeus), was introduced from Hawaii by the Philippine Sugar Association, with the coöperation of the College of Agriculture. Nine birds, which had been rather weakened by ocean voyage, were released in 1928 on the College Campus. Up to the present, however, no individual of this species has been recovered from the field. Of the beneficial insects, attempts at introducing the following forms were made by the College of Agriculture, either on its sole responsibility or in coöperation with other entities (Uichanco, 1928; Uichanco and Villanueva, 1932). However, it can not as yet be determined whether they are established or not.

BENEFICIAL SPECIES	INTENDED HOST	SOURCE	YEAR RELEASED
Encarsia flavoscutellum Zehntner	Ceratovacuna lanigera Zehntner	Java Formosa	1928 1929
Ceromasia sphenophori Villeneuve	Rhabdocnemis lineatocollis Heller	Hawaii	1928
Telenomus nawai Ashmead	Spodoptera mauritia Boisduval	Hawaii	1928
Euplectrus platyhypenae Howard	Spodoptera mauritia Boisduval	Hawaii	1928
Cryptolaemus montrouzieri Muls.	Mealy bugs	Hawaii	1929

Medical and veterinary entomology. A limited amount of work has been done on insects affecting man or his domestic animals, as workers whose special inclinations lie along these lines became attached to the Department. Banks, in continuation of his earlier work in the Bureau of Science, published on *Phlebotomus nicnic,* new species, which is the most annoying owl midge in many Philippine localities (1919a), blood-sucking insects of the Philippines (1919b), and swarming of anopheline mosquitoes (1920). A common foot-maggot of the carabao had been familiar to the local farmers for a long time under the Tagalog name of "kayuko"; but was

Fig. 2.—A corner of the technique room, Department of Entomology. Student assistants are mounting and preparing material; cases filled with specimens are at the left; in the background the electric drier, with one unit open, showing specimen cases to allow drying.

unknown to science until Aldrich (1923) described it from Los Baños material as *Booponus intonsus,* new genus and species, and Woodworth and Ashcraft (1923) reported on its biology and control.

Insecticidal and other repressive measures against agricultural pests. The earliest report on *Derris* as an insecticide in the Philippines was embodied in a paper by Castillo (1926), who found that a species, which was mistakenly determined as *polyantha* Perkins, but later found to be of unsettled identity, was much more effective

in killing insects than either the commercially well established *elliptica* (Roxb.) Benth, or *philippinensis* Merrill.

Since Cevallos (1911b) made his preliminary spraying tests of common insecticides, efforts have been consistently made to find suitable formulæ for standard contact and stomach poisons for use under Philippine conditions. The results are brought together in our mimeographed laboratory directions for introductory entomology, which is now in its fourth edition (Uichanco, 1930). Coronel (1928) made a two-year field test of arsenicals against tobacco worms and found that either lead arsenate spray or calcium arsenate dust applied at most five times, at six-day intervals, from the time the insects began to be noticed on the leaves, resulted in a safe, effective, and cheap method of control. Madrid (1934a) concludes that treatment of watermelon, squash and other cucurbits with either of these two arsenicals, three applications, at intervals of from five to seven days, from the time of appearance of the first true leaves of the seedlings, satisfactorily prevents damage by *Ceratia similis*.

Coal tar-kerosene emulsion, a mixture developed by our laboratory out of common local ingredients, can be prepared quite cheaply; it fills a real need as a versatile insecticide and repellant in (*a*) preventing termites from attacking sugar cane and other plant cuttings in the soil prior to germination, (*b*) keeping ants away from seed beds, (*c*) protecting fruit and shade trees from borers, (*d*) corralling white grubs, and (*e*) as dips to control the carabao-foot maggot (Uichanco, 1931a; Madrid, 1934b). Likewise, a method of destroying nests of ground-inhabiting ants and termites by floating mineral oil on water (Uichanco, 1931b) and that of fumigating beetle- or drywood termite-infested woodwork of buildings, using watersoaked newspaper as cover, have greatly facilitated and rendered more effective these once rather difficult and uncertain methods of control. A simple hand duster that can be made in the home out of waste material has placed in the hands of the average home gardener of modest means a convenient device for applying insecticides in dust form (Uichanco, 1932).

Controlled observations on the common Philippine structural bamboo (*Bambusa spinosa* Roxb.) point to the undependability of the time-honored practice of a fixed cutting season as a means of preventing attack by powderpost beetles (Uichanco, 1927). Of the bamboo stems cut in any month of the year, including the supposed cutting season, certain pieces, even though presumably mature, were found to be susceptible to infestation. However, one im-

portant point brought out in our work was that susceptible pieces began to show beetle invasion within one month after cutting. The experiments have since been continued and our material seems to indicate that stems which showed immunity during that first month have continued to be pest-free; hence, a practical method of selecting bamboo for more permanent construction. Unfortunately, the same criterion cannot be applied to the cheaper *tewanak, Bambusa vulgaris* Schrad., which seems to be unusually attractive to powder-post beetles.

With respect to corn, whole ears with husks and stigmas left intact, when sundried to constant weight, showed after seven months in storage an average of only 10.07 per cent weevil-damaged kernels, thereby reducing infestation by 56 per cent, compared with shucked ears (Uichanco and Capco, 1934). If not previously sundried, however, husks and stigmas served to increase, rather than deter, the injury. Corn ears with husks and stigmas on and hung on racks, as is commonly practiced in the Philippines in storing seed corn, kept better in partial shade than under full exposure to sunlight.

Animals other than insects. Biological and systematic work was done, incidental to the teaching of introductory zoölogy in the Department of Entomology, on some of the common land and freshwater animals in the neighborhood of the College. The papers by Baker (1915) and by Chilton (1920a, 1920b) on Amphipoda apparently constitute the only Philippine records of this group. A basic faunistic report on snakes, turtles, lizards and amphibians of the Maquiling area (Taylor, 1922) is almost entirely the result of collecting activities of this Department. The work of Reveche (1923) on *Dermogenys viviparus* Peters; of Mane (1929) on the kandule, *Arius* spp.; of Manuel (1930) on the weaver, *Munia jagori* Martens; of Villadolid and F. G. del Rosario (1930) on tulla, *Corbicula manillensis* (Philippi); of Villadolid and N. del Rosario (1930) on frogs, especially *Polypedates leucomystax* (Gravenhorst); of Alonte (1930) on the common freshwater snail, *Vivipara angularis* Müller; of Manacop (1932) on *Gulaphallus mirabilis* Herre; of Buñag (1933) on dulong, *Mirogobius lacustris* Herre; of Mane (1934) on ayuñgin, *Mesopristes plumbea* (Kner); and of Arriola (1934) on biang-puti, *Glossogobius giurus* (Hamilton-Buchanan) are a contribution to our knowledge of the feeding and breeding habits and other biological peculiarities of these abundant, and in many cases economically very important, animals. One interesting phenomenon exhibited by the foregoing species is that a large majority of the aquatic animals are characterized by well marked sea-

sonal periodicity in their spawning peaks. Moreover, among forms that feed at or near the water surface, as in two species of snails, *Vivipara angularis* and *Ampullaria luzonica*, and two species of gobiid fishes, *Mirogobius lacustris* and *Glossogobius giurus*, such peaks occur in the rainy season; while in bottom or deeply submerged feeders, as in the fishes *Arius* spp. and *Mesopristes plumbea*, and in the clam, *Corbicula manillensis*, the height of spawning takes place in the dry season. These curious differences in behavior of animals, with no apparent regard for zoölogical relationships, suggest a beautiful problem in ecological adaptation, in which fluctuations in food abundance probably play a leading part.

The question of conservation of wild animal life, especially fishery resources, have been considered, both as parts of the articles cited above and as special projects (Villadolid, 1932a, 1932b, 1932c, 1933; Monje, 1933). This phase of our laboratory's activities, although a minor part of its function, has proved useful in that it served as a training ground for men who later on were to assume a major rôle in establishing an allied undertaking in the Fish and Game Administration of the Department of Agriculture and Commerce.

A beneficial insect, the wasp *Scolia manilae* Ashmead, recruited from Los Baños, has been one of the most important factors in saving the Hawaiian sugar industry.

The six year curriculum of the College of Agriculture (based on intermediate graduation) was discontinued on April 1, 1929.

The fundamental problem of man, whatever the fortuitous accidents and conditions of his temporary type of civilization, is man himself.—JAMES TRUSLOW ADAMS.

"Time wasted is existence; used, is life."

Robert L. Pendleton

PILI DRIVE IN THE EXPERIMENT STATION

Framing cloud-encircled Mount Maquiling, this road leads to the Animal Husbandry group.

A QUARTER CENTURY OF WORK ON ANIMAL IMPROVEMENT [1]

Miguel Manresa
Of the Department of Animal Husbandry

It is the purpose of this article to describe briefly what the College of Agriculture has attempted to do and what it has accomplished in its work on animal improvement during the last twenty-five years. The work may be divided into two periods: (1) period of experimentation in studying the adaptability of the well established breeds of improved types of live stock, and (2) period when definite steps were taken to form new breeds suited to our climate and adapted to our methods of farming.

CATTLE

Indian Nellore cattle, Hereford, Philippine Native, Holstein, and the Crosses therefrom

Among the different breeds of improved cattle from the temperate regions the Herefords, owing to their grazing capacity, hardiness and ability to rustle in open ranges, gave the greatest promise of being one that could become adapted with success to the Philippines. In seven years time, that is, from December, 1920, to January, 1928 when the last purebred Hereford bull died, only fourteen purebred Hereford progeny bred in the Philippines had been obtained. At present there is not a single purebred Hereford in the College.

The Indian Nellore cows raised 77 per cent of their young to sexual maturity; the Philippine Native, 72 per cent; the Herefords raised only 42 per cent. In the matter of rearing their young the Hereford cows were not as successful as the Holstein which raised 50 per cent. With few exceptions the duration of life of the purebred Herefords born and raised in the College was very much shorter than either the Philippine Native or the Indian Nellore cattle.

On the other hand, the crosses Hereford × Philippine Native and Hereford × Indian Nellore have done well. But as the percentage of Hereford blood was increased by top-crossing, the progeny resulting reverted to the pure Hereford parents in constitutional weak-

[1] General contribution from the College of Agriculture No. 420.

ness. Thus, the percentage of survival of the grades possessing one-half Hereford and one-half of either Native or Nellore was found to be 84 per cent. In those possessing three-fourths Hereford, 80 per cent survived, and in those having seven-eighths Hereford blood the percentage of survival was only 50 per cent.

Foundation stock for the Philamin breed of range cattle

It having been amply demonstrated that cattle of Western origin are unsuitable for propagation in the tropics, Dr. B. M. Gonzalez, Head of the Department, after very full consultation with his associates decided about six years ago to begin a well planned project of forming a breed of range cattle suited to our climate. The aim is to blend into one breed, the hardiness, good grazing qualities and resistance to disease of the Nellores; the docility, efficiency as work animals and prolificacy of the Philippine Native; and the rapid rate of maturity and excellent beef conformation of the Herefords. The heritability of those characters has been demonstrated, and considered from both the theoretical and practical viewpoints there appears to be every hope of success, provided that the work is pushed on continuously and assiduously.

At the time the plans for this work were being completed there was a sufficient number of crossbred animals in the Department from which the foundation stock could be selected. The data on our experiments in crossbreeding cattle served a very useful purpose as a guide in forming the plans (Sarao *et al*, 1933). These data showed that the animals possessing one-half Hereford blood, one-fourth Nellore and one-fourth Native were superior to all other combinations in point of weight, rate of maturity, and percentage of survival. After considering the merits of a number of individuals, five cows were selected as foundation cows. The bull selected to head these cows had one-half Hereford and one-half Indian Nellore blood. Already some very high class individuals have been produced.

The name *Philamin* has been proposed for this breed that is being evolved as the name will indicate the blood we are attempting to blend; thus, *Phil* for Philippine, *Am* for American Hereford, and *In* for the Indian Nellore. No claim is made for originality in the method pursued in this work of producing a new breed of cattle. The creation and purification of breeds of live stock by blending together the desirable qualities of animals from two or more different breeds has often been done by practical animal husbandmen. Under carefully controlled scientific methods made possible by the

knowledge of genetics many new breeds have come into being. Experimental verification of this in the Philippines is found in our Berkjala breed of swine, now a fairly well-established breed of pigs.

Purification and improvement of the Indian Nellore and the Philippine Native cattle

The objectionable characteristics of the Nellore and the Native cattle are fairly well known in the Philippines. Undoubtedly these characteristics could be eliminated or largely minimized by proper breeding. Our present herd of Nellores, started in 1918, affords

Fig. 1.—Rebecca. One of the foundation cows of the Philamin breed of beef cattle being developed in the College of Agriculture.

ample evidence on this point. The Department herd of Philippine Native cattle is as yet small but it forms a nucleus from which to accomplish a definite breed of improved Native oxen. This work will, of course, require a relatively long time but since it should be done, the sooner it is started the better it will be for the live stock industry of the country. Bakewell, during his lifetime, achieved very notable results in his work along a similar line with the Longhorn cattle of England. Our Los Baños Cantonese breed of chickens was improved by methods similar to those employed by Bakewell.

THE CARABAOS AND INDIAN BUFFALOES

Fresh milk is as essential to the Filipino farmer as beef. Hence, in selecting the foundation carabaos Doctor Gonzalez gave proper attention to their dairy characteristics. Animals which had a good reputation as milkers were chosen, provided, they also excelled in other respects. In view of the increasing spread through health organizations of the knowledge of the value as a food of fresh milk and the resulting increase in demand, the outlook for the dairy industry in the Islands is very auspicious. The carabao offers great possibilities, as Filipinos having taken care of these animals and worked with them for so many generations will find it easier to learn how to manage them for milk production than they would others.

We now have complete records of twenty-two complete lactations in the Native carabaos, Indian buffaloes and crossbreeds. These records show the average yield of the carabao cow of the Department during her period of lactation to be 2.1 liters a day, with maximum daily yields varying from 2.6 to 5.3 liters. The highest daily production of 5.3 liters was by a Native carabao cow, Iba, in her 15th year in the course of a lactation period covering 365 days. The average of the Indian buffalo cows was 2.8 liters a day, with maximum daily yields varying from 3.9 to 7.1 liters. The highest daily record of 7.1 liters was made by a cow, Ana's Pride, in her third lactation of 242 days. The first generation crosses, Native carabao × Indian buffaloes, made an average of 2.9 liters per lactation per day, the maximum daily records being from 5.6 to 7.9 liters. The highest daily record of 7.9 liters was made by a crossbred cow named Indipinas during her fourth lactation which covered 298 days (Sarao, 1934).

Both breeds of carabaos thrive well in the Philippines and respond favorably to rational methods of feeding and management. The work on these classes of animals in the College of Agriculture, therefore, consists in effecting parallel improvement carried out independently. Crosses between Native carabaos and Indian buffaloes are made for the purpose of producing crossbreeds, not up-graded animals, required for immediate use only. The female crossbreeds are placed in the dairy herd and the males are castrated and broken for farm work. Any animal possessing more than one-half of the blood of either breed is prevented from reproducing by early castration or spaying.

By practicing rigid selection we have found it possible to reduce the number of animals in the herds into the lowest optimum. If number alone and not quality were the principal objective of our

work the *laissez faire* method of animal production would achieve that objective. But improvement has been attained more frequently in smaller herds of carefully selected and well managed animals than in larger ones. In any live stock improvement the individual, not the mass, is the basis upon which the breeder must operate.

HORSES

As early as 1911 Professor S. B. Durham, the first Head of the Department, observed that the introduction of Spanish, Australian and American breeds of horses into the Philippines had invariably resulted in failure. In our breeding work we attempt to utilize the Filipino pony as basic stock in forming a general utility horse by infusing the blood of some of the smaller breeds of imported horses, notably, the Arabian. The aim is to produce a horse of fair size, good temperament, well-balanced action, and of medium speed at the walk and the trot, a horse which can perform many odd jobs on the farm and be used as a saddle horse.

Two misfortunes have prevented steady progress in this work. First, the outbreak of surra in our herds in 1919, which disease reappeared in 1933; and secondly, the incidence of osteoporosis in the breeding stock. These diseases have caused the mortality of many animals in the herd. The surra in 1919 was promptly checked by the killing and destruction of the infected individuals as soon as the surra organisms were detected by the microscope, and it is hoped that the recent outbreak, already under control, may be stamped out altogether. The problem offered by osteoporosis was attacked differently. This disease proved to be constitutional, the hereditary nature of which was traced by our own researches to one of the animals used as foundation stock. It has been the policy of the Department to attack the problems affecting its work not by palliative treatments which appear to be expedient at the moment, but by the thorough painstaking methods of science with a view of determining the real cause. Invaluable data have been secured as a result of this policy.

The earliest reference regarding the hereditary nature of osteoporosis was reported by Bitting in 1894.[2] It was thirty years before the next work appeared (Bordeaux, 1924).[3] The latter work, however, did not furnish any significant additional fact to the first

[2] BITTING, H. W. 1894. Big-head (osteoporosis). Florida Experiment Sta. Bull. No. 26. *Cited in* U. S. Dept. Agric. Exper. Sta. Rec. 7: 61. 1895.

[3] BORDEAUX, E. F. J. 1924. Bone disease in horses. A clinical study. Journal Comparative Pathology and Therapeutics 37: 27–37.

beyond merely indicating the "very strong hereditary predisposition of some horses" to the disease. Any theory regarding the transmission of heritable characteristics is likely to be of no great value unless it can be backed up by direct experimentation. In their paper on osteoporosis, Gonzalez and Villegas (1928) demonstrated beyond reasonable doubt the heritability of osteoporosis, a disease now called osteomalacia by recent investigators. The nature of the transmission of this disease having been determined control measures are now being instituted toward the prevention of breeding of the affected individuals.

GOATS AND SHEEP

The Department acquired its first herd of goats in 1913. Although these goats were mostly of Native stock they did not thrive well because they were left in the pastures by themselves receiving little attention. By 1922, that is, after nine years of goat raising without rational management almost all of the original stock had perished from various causes (Villegas, 1929). With the introduction of new stock consisting of first the Indian breed of goats in 1922, and later the Spanish and Anglo-Nubian, definite methods of management were instituted. Particular attention was given to the shelter of the animals, to pasturing, feeding of concentrates to milch does, salting and watering (Villegas and Pablo, 1926). Milking the does with the view of raising the young was carefully studied (Limpiado, 1929).

These studies have disclosed some of the reasons that goat production has not flourished in the Philippines. Among these reasons the heavy mortality of the young is foremost. More than fifty per cent of the animals that have died in our herds were found to be heavily infested with intestinal parasites. The most common of these parasites were stomach worms (*Haemonchus contortus* Rudolphi) and tape worms (*Moniesia expansa* Rudolphi). Under better methods of feeding and management the mortality that is due to these parasites could be considerably reduced (Boncato, 1932). Very encouraging results from better management have already been secured both in reducing the mortality caused by intestinal worms and in increasing milk production. We now have some does in the herd that give more than two liters of milk a day. One doe yielded 390 liters during a lactation period lasting 202 days, or an average of 1.9 liters a day for the entire period (Villegas, 1932).

The first stock of sheep introduced into the Department in July, 1922 included one purebred Indian ram and two Indian-Merino

ewes. Our experience with sheep is similar to that with goats. Both of these animals are highly susceptible to the effects of intestinal parasitism. Success in raising sheep is attained only after a method of management that is suitable in the given locality has been evolved and put in practice. When properly cared for the sheep live long in the Philippines.

SWINE

Twenty-five years of experience in Philippine animal husbandry work has convinced us that it is futile to attempt to perpetuate bodily in the Philippines improved purebred swine from temperate regions. The work on swine in the Department has given most convincing proof that further effort in this line is useless (Gonzalez and Lago, 1923; and Gonzalez, 1926). In the pioneering stage of our work on animal improvement it appeared logical to direct action toward the establishment of a stock of swine that could live under our climate. Of all the crosses that had been made between the Philippine Native swine and the imported pure breeds, the Jalajala × Berkshire had given the most promise of success. The Jalajala pigs are of fair size but rather slow maturing and have poor body conformation. In these characters the Berkshire excel but they can not withstand the effects of parasitism. The most important character of the Jalajala pigs is adaptability to environment. After having determined the proportion of the Berkshire blood in the crossbreeds that can thrive in the tropics, definite steps were taken toward the formation of a new breed. This work has been going for about nineteen years. The present herd of Berkjala pigs in the Department is the reward for the work.

In 1931 all the data pertaining to Berkjala on file in the Department were studied with the object of finding what accomplishments, if any, had been secured as regards the essential characters of the Berkjala pigs, special emphasis being placed on such characters as would make them suitable for profitable raising on large farms on a commercial scale (Banaag, 1931). The time from 1916 to 1930, inclusive, was divided into three periods of five years each. Every record of 1,693 individual pigs in 252 litters was included. The data showed the existence of progressive increase in the duration of life of the sows that were retained in the herds for breeding purposes. The size of litters suffered a fall during the second period but was restored during the third period. The number of pigs weaned was also lower during the second period but was gradually raised so that by the end of the third period the percentage

of pigs weaned was higher than in the first period. Towards the end of the third period the pigs were more uniform. Some of the important points aimed at in the establishment of the breed are: (1) ability of the sows to produce two litters of pigs in one year with at least eight pigs to the litter, and being able to wean 80 per cent of the young, (2) the attainment of 80 kilograms weight at the age of one year and 120 kilograms at maturity, and (3) the production of a ham-bacon type of hogs that will breed true to type.

By using an index for selection based on arbitrary standard requirements, it has been possible to gradually shift the direction of the work towards these three objectives. In accordance with this index the present requirements for the sows are: (*litter size*), a minimum of six pigs to the litter at the first farrowing, seven in the second farrowing, eight in the third and subsequent litters; (*motherly characteristics*), being able to raise not less than 75 per cent of the young in each litter; and (*milking quality*), a minimum total weight of the litter at weaning time of not less than 50 kilograms for the first, 60 kilograms for the second, and 80 for the third and subsequent litters. It is obvious that, if progress is to be kept up, these limits will have to be raised continually; this must be done as soon as the majority of the animals in the herd can satisfy the given requirements with ease. All animals rating low selection indices are, of course, discarded from the breeding herd.

The present stock of Berkjala pigs in the Department possesses all the qualities essential to the efficiency of a type of hog suitable for raising on well organized farms in the Philippines. The animals are hardy, early maturing, growthy and prolific. They are good feeders responding favorably to rational methods of hog production on a commercial scale. The standard color of the breed is solid black. Their characteristic markings are: shortness of head with slightly dished face, absence of wrinkles except for an inverted V-shaped fold of the skin over the forehead, and curling tail. The shape and carriage of the ears are similar to these of the Berkshire (Mondoñedo, 1933).

POULTRY

In any line of endeavor, the definite advancement secured gradually through a well constructed program encourages one to push on, and the thought of being able to serve the interest which the work represents is a source of inspiration. Such is the spirit which the poultry work of the Department creates in one who knows it and has seen it function.

The work towards the promotion of the Philippine poultry industry was first centered in the acclimatization of foreign breeds of poultry in the Islands. The repeated failures encountered in attempts to adapt bodily the standard breeds of poultry of Western origin in the Islands have been so adequately discussed in numerous publications that further comment is unnecessary. Black Orpington, Rhode Island Red, Barred Plymouth Rock, Single Comb White Leghorn and Black Minorca were tried in the College and the result was invariably failure. Largely because of these failures, the introduction of breeds of chickens from the neighboring countries was next attempted. This was first started in 1916 with a stock of unimproved chickens from Canton, China. These fowls are generally called Cantonese in the Philippines, but the strain that was

Fig. 2.—Egg-laying contest houses where the performance of different breeds of fowls is being determined.

developed and improved in this College is now known all over the Philippines and elsewhere as the Los Baños Cantonese.

The original stock used as foundation animals had no uniformity in type, size, color or performance. Intensive inbreeding was soon instituted accompanied with rigid selection for vigor, type and performance in egg production as well as in size. Proper methods of feeding were methodically studied. The records of pullets for the year 1917–1918 show an average egg yield of 29.8 per bird a year. This average was raised to 109.7 eggs a year in 1923–1924 (Fronda and Gonzalez, 1927) and in 1932–1933, three pens of unselected Los Baños Cantonese pullets averaged for the year 132.6, 134.4 and 139 eggs a pen (Chan and Guiyab, 1934). The highest individual egg record of this breed is 237 eggs a year, made by "Miss Aggie" of the College of Agriculture in 1928–1929 (Fronda, 1929).

From 1918 to 1924 the weights of the pullets' eggs were improved by 20 per cent. The weights of the cockerels and the pullets increased by 33 and 43 per cent, respectively. The age when the pullets started to lay eggs was 248.2 days in 1917–1918 and 219.8 days in 1923–1924. The latest records show that the Los Baños Cantonese pullets are sexually mature at the age of 179 days or approximately six months (Tioaquen, 1933). In the years that followed the work was concentrated upon the purification of the breed. Improvement in the methods of rearing was given particular attention. The results of this work became patent about four years ago in connection with the egg laying contests conducted under the auspices of the College of Agriculture. In the First Egg Laying Contest in which Single Comb White Leghorn, Nagoya, Mikawa, and Rhode Island Red besides Los Baños Cantonese competed, one pen of Los Baños Cantonese pullets averaged 164.3 eggs each in 365 days (Fronda, 1932). The Los Baños Cantonese brought in the highest returns from eggs produced over cost of feeds. In the Second Egg Laying Contest the Los Baños Cantonese again ranked first in economy of egg production though not in number of eggs (Fronda, 1933).

Results such as these speak for the Los Baños Contonese as a dual-purpose breed of chickens. In the year 1930 the breed was reimported back to Canton, China by the Lingnan University, and in the same year the breed invaded the territory of the United States for the first time. It was on August 15, 1930 when nine golden buff pullets and two roosters similarly colored were placed on board the *S.S. Empress of Asia* en route to the University of Illinois, Urbana, Ill., U. S. A. via Vancouver, British Columbia. This was probably the first time that an improved breed of live stock crossed the Pacific Ocean from the Philippines. There are now many poultry farms in this country that are specializing in Los Baños Cantonese, and recently, on May 13, 1934, one of these farms shipped a flock consisting of 3 males and 12 females to Siam where they are expected to serve as foundation stock for the improvement of Siamese poultry.

Encouraged by the results with the Los Baños Cantonese, work was started in 1922 to improve the Philippine Native chicken. A pen of brown feathered birds with black shanks and white skin was isolated. Only birds that produced chicks possessing the desired characters were retained in the flock and these were inbred. While no systematic attempt had as yet been made to select for egg production, the highest egg record made by a Native pullet in one year was 197 eggs (Villegas, 1929). Earlier studies on the Native chickens showed that they were poor layers, the average obtained from thirty

hens in 365 days being only 43 eggs. Confinement in a yard enclosed with wire fence affected egg production adversely, as the hens which were allowed to move around a wider range where they could rustle for part of their feed laid more eggs (Allarey, 1912). This character must be bred out in view of the coming of intensive methods of farming which will necessitate raising chickens in relatively small areas enclosed with fences.

Returning from Tokyo, Japan, in 1926, where he had attended the Third Pan-Pacific Science Congress, Dr. B. M. Gonzalez, now Dean of the College, brought with him thirty eggs of the Nagoya breed of chickens developed in that country. The present stock of Nagoya chickens in the College of Agriculture originated from those eggs (Fronda and Gonzalez, 1929). Our experience with the Nagoya chickens during the last eight years warrants the statement that there is still more work to be done in improving this breed. Recent studies in which the Nagoya birds were compared with the Los Baños Cantonese showed that in the rate of sexual maturity, performance and in economy of egg production the former are still inferior to the latter. The average age of maturity of thirty unselected Nagoya pullets was found to be 201 days and the eggs which they produced in 365 days were 131.5 a pullet (Tiaoquen, 1933; and Martir, 1933). These averages are lower than those of the Los Baños Cantonese. It should be mentioned, however, that the highest official individual record made by the Nagoya breed in this country is 242 eggs a year. This record was made by "Maquiling-san" of the College of Agriculture (Fronda, 1933).

The published contributions from the Department is a long list. On poultry practically all those operations incident to breeding, rearing of the birds for food purposes, and the preparation of their products for the market have been covered. These results and others which for lack of space cannot be incorporated in this brief report of our work have been made available to the general public by means of bulletins, circulars, popular articles, books and lectures to interested groups.

A man cannot most intelligently and efficiently direct others in any great industrial work, without understanding to a finish the basic scientific principles underlying that work and without being able to do the things himself.

CONTRIBUTIONS OF THE DEPARTMENT OF ANIMAL HUSBANDRY TO PHILIPPINE ANIMAL DIETARY [1]

ALEJO T. TALEON
Of the Department of Animal Husbandry

One of the main objectives of the Department of Animal Husbandry is the improvement in the methods of feeding live stock and poultry. To be able to attain this, it is necessary that an accurate knowledge of the feeding value of local feeds be known. Early workers found themselves confronted with a very limited variety of feeds, particularly those of animal origin recognized as very important in animal dietary. In the following pages, the results of the work of the Department along this line during the twenty-five years of existence of this College are given.

CEREALS AND THEIR BY-PRODUCTS

Corn. In the Philippines, corn grain is one of the most widely used feeds for animals. It is valuable particularly for swine and poultry. But price and availability limit its use for live stock feeding in some regions.

Corn alone or used with either cowpea or sweet potato pasture was found to be inferior to rice bran for growing and fattening pigs. When one half of corn was replaced with rice bran the results were better (Bautista, 1918; Allas, 1924).

In a self-fed, free-choice system of fattening swine, with sweet potato pasture, corn with copra meal was a better feed than when rice bran was used instead of corn (Lago, 1924). For eight-month-old gilts on scanty grass pasture, a ration with corn constituting 20 per cent was slightly inferior to one containing 40 per cent of unpeeled, raw chopped cassava; although at the end of the test the corn-fed pigs had a better finish. But for pigs three to six months old on sweet potato pasture, one-half of the corn in the ration containing rice bran, copra meal and dried shrimps may be replaced with three times as much cooked cassava. Without pasture, more than one-half of the corn in the ration may be replaced by three times as much cassava. For older pigs, without roughage, the substitution of cooked cassava for one-half of the corn in the ration made

[1] General contribution from the College of Agriculture No. 421.

the pigs grow faster and the ration was more economical (Mondoñedo and Bayan, 1927; Mondoñedo, 1928).

To produce gain, ground corn when fed to growing pigs was found to be slightly better than whole corn or three parts cooked cassava. As supplement to rice bran and copra meal, corn was superior to cooked sweet potato, cassava and poñgapong. It was found that cracked corn could be replaced in the ration with cracked or soaked palay (Mondoñedo and Bayan, 1927; Bolivar, 1928; Mondoñedo and Alonte, 1931; Garcia, 1933).

For pigs on pasture, 20 per cent corn in a ration had the same feeding value as 20 per cent molasses. For older pigs, however, corn was superior to molasses although the molasses gave better results in preparing show animals (Gochangco, 1933).

For poultry, corn was observed to be less palatable than palay but more so than sorghum grain. As a basic constituent of mash mixture, corn meal was superior to rice bran in palatability, and it made unpalatable concentrates as copra meal and calamismis meal more palatable (Tuason and Fronda, 1924). For brooding chicks and rearing pullets, corn was found to be as palatable as palay and produced better results. For fattening purposes, in combination with mungo, corn proved to be as good as palay (Cruz, 1918; Chan and Guiyab, 1934).

Corn as the only grain, and constituting 50 per cent of the mash mixture, was found to be equal to palay for egg production (Chan and Guiyab, 1934). When fed to ducks corn produced eggs of better quality than those that were given palay (Alcasid, 1919).

For feeding work bullocks, shelled corn as supplement to pasture grasses improved slightly the health and ability of the animals to work (Lago, 1919; Sanchez, 1923).

Tahup. Tahup is a by-product in the milling of corn "grits" a food used by the people of Cebu in place of rice. It consists of the germ, hull, tip cap and a portion of the endosperm of the corn grain. Tahup is available in many places in the Islands and is used for live stock feeding, principally for swine.

It was observed that, for weanling pigs, tahup was inferior to rice bran, and for fattening pigs it proved to be 82 per cent as efficient as the bran (Aguanta, 1934). With laying hens a ration containing 60 per cent of tahup and supplemented with copra meal and fish meal, produced more eggs than a ration in which rice bran was used in place of tahup. But when equal parts of both tahup and rice bran were used in the same ration better results were obtained than in either of the other two (Fernandez, 1934).

Palay (rough rice). Rice, besides being the staple food of the Filipinos, is also commonly fed to poultry. In experiments in the College, palay was found to be more palatable to chickens than cracked corn or sorghum (Tuason and Fronda, 1924). But it was inferior to corn for feeding chicks and young pullets. For egg production palay was about equal in feeding value to corn (Chan and Guiyab, 1934).

For ducks, however, palay fed in combination with rice bran gave better results than corn or a combination of palay and corn. But the quality of eggs of palay-fed ducks was inferior (Alcasid, 1919).

For growing and fattening pigs on common grass pasture and sweet potato soilage, soaked or cracked palay constituting 15 to 25 per cent of the concentrate mixture had about the same feeding value as corn. Palay produced better gains when cracked than when soaked (Garcia, 1933).

Rice bran. Rice bran, a by-product in the milling of rice for human food, is widely distributed and cheap. Its principal use is for feeding swine. Two grades of rice bran are found in the market, the coarse and the fine grades. For weanling pigs on pasture, fine rice bran constituting 60 per cent of the ration, gave much better results than the coarse rice bran, and a combination of fine and coarse rice bran produced intermediate results (Tirol, 1933).

For growing and fattening pigs, either on pasture or in dry lots, rice bran gave better results than shelled corn (Bautista, 1918). Rice bran, fed with copra meal, self-fed, self-choice, and with sweet potato pasture was less efficient for fattening purposes than corn (Lago, 1924).

For weanling pigs on sweet potato pasture, rice bran was better than a mixture of rice bran and corn and much better than either corn alone, or a mixture of corn and copra meal. But a combination of rice bran and copra meal produced better gains than rice bran alone. Rice bran was also better than cassava refuse meal (Allas, 1924).

For poultry, rice bran alone was not palatable. Mixed mashes with rice bran as the basic feed were also less palatable than when corn replaced rice bran (Tuason and Fronda, 1924). For chicks, rice bran constituting 60 per cent of the ration was more palatable than cassava refuse meal, and produced better results (Tabayoyong, 1934). In the mash mixtures where corn meal was replaced with fine rice bran, weight for weight, the effect on egg production was slightly better than when the corn meal was used (Fronda, 1932).

Mungo. Mungo (*Phaseolus aureus* Roxb.) is of wide distribution in the Philippines where it is used mainly for human food. Because of the relatively high percentage of protein it contains, it can be incorporated in live stock rations to improve the quality.

For feeding carabao calves, mungo was found to be about equal in value to copra meal when used as supplement to rice bran and corn meal (Sibal, 1925). For feeding poultry, ground mungo was found to be not very palatable, but adding corn meal improved the palatability, although the mixture was not as palatable as corn meal alone (Tuason and Fronda, 1924).

When mungo made up 20 per cent of the ration, the chicks did not develop normally. But, with the ration containing 10 per cent each of mungo and of shrimp meal, the results were fairly satisfactory. Mungo may be used as a supplement in rations for chicks, but its high cost prohibits its general use (Adan, 1934).

Copra meal. Copra meal is a by-product in the extraction of oil from copra. Its value as feed lies mainly in the high percentage of protein it contains.

As a supplement in rations for pigs, with sweet potato soilage, copra meal produced better results with rice bran than with corn meal (Allas, 1924). When copra meal was given in self-feeders, free-choice, the pigs consumed more copra meal to supplement rice bran than they did to supplement corn (Lago, 1924). Pigs fed copra meal grew slower and required more feed to make one kilogram of gain than pigs fed shrimps or tankage (Santiago, 1926; Perez, 1931). It was observed also that rations for shotes, either on the pasture or in dry lots, should not contain more than 30 per cent copra meal (Gallardo, 1930).

It was found that copra meal was as efficient and more economical than mungo in promoting growth of carabao calves (Sibal, 1925).

Although copra meal was not as palatable for chickens as dried shrimps, dried fish and mungo, the addition of corn meal increased its palatability (Tuason and Fronda, 1924). But copra meal as a sole supplement in rations for chicks was found unsatisfactory; it should not form more than 20 per cent of a chick ration. A mineral mixture containing calcium phosphate, calcium carbonate and sodium chloride did not improve the rations containing 20 or 50 per cent of copra meal (Ferrer, 1921; Moncerate, 1922; Mamaril, 1923; Mariano, 1923; Mallonga, 1934). Hens fed copra meal showed poorer production than those fed snails, dried shrimps, or cowpeas (Fronda, 1919; Goseco, 1921; Buenaventura, 1922; Serrano, 1928. It

was found, however, that copra meal, may be profitably used in the ration for egg production, provided that the ration does not contain more than 20 per cent (Crucillo, 1926).

ANIMAL PROTEIN SUPPLEMENTS

Dried shrimps. In seeking for good feeds of animal origin, of which there is a lot in this country, dried shrimps were found to be a valuable supplement in rations for swine and poultry. This was fortunate for College feeding as prawns (*Palaemon lanceifrons* Dana), commonly known as shrimps, are caught in large quantities in Laguna de Bay. The utilization of this feed for poultry dates from 1922, when Dr. F. M. Fronda of this Department started to use it in rations for chickens.

Palatability tests showed dried shrimps to occupy first rank when compared with other feeds (Tuason and Fronda, 1924); Santiago, 1926; Serrano, 1928; Fronda, Badelles and Padilla, 1934; Adan, 1934; San Pedro, 1934). As a supplement to an egg-laying ration, used in the amount of 20 per cent, dried shrimps (shrimp meal) produced better results than meat scraps, fish meal or tankage (Francisco, Chan and Fronda, 1934). Similar results were obtained when dried shrimps were used as a supplement in rations for brooding chicks (Fronda, Badelles and Padilla, 1934). This protein supplement also produced much better results than mungo. The results with one-half dried shrimps and one-half mungo were, however, intermediate between the two used singly as supplement in growing rations (Adan, 1934).

The optimum amount of dried shrimps which may be used as supplement in a ration for chicks was found to be 25 per cent (Kabigting, 1934). Compared with buttermilk for chicks, dried shrimps when incorporated to the amount of 25 per cent of the ration proved to be the better. Replacing a part of the dried shrimps with powdered buttermilk improved the ration (Denoga, 1934).

Used as a supplement to corn meal and rice bran for feeding ducks, dried shrimps proved better than fish meal or snails (Cruz, 1931).

For sows and suckling pigs, five to ten per cent of dried shrimps in the ration was about the same in feeding value as meat scraps (Belandres, 1932; Villareal, 1932; Villaroel, 1932). For weanlings, this supplement was superior to tankage or copra meal; and for barrows better than copra meal (Santiago, 1926; Perez, 1932).

With pigs, 2–1/2 to 5 months of age, it was found that those getting 10 per cent of dried shrimps in the ration produced the best

results; for older pigs, 5 to 9 months of age, the ration containing 5 per cent dried shrimps was the most efficient (Angel, 1932). For fattening pigs on sweet potato pasture, dried shrimps were not found to be any better as a concentrate than corn, rice bran or copra meal (Lago, 1924).

Fish meal. Fish meal, a by-product in the fish oil industry, was formerly imported as fertilizer but it is now used in large quantities for poultry feeding. It is palatable and as a mash constituent for chickens, it produces satisfactory results (Tuason and Fronda, 1924; Fronda, 1929). For brooding chicks, 20 per cent fish meal in the mash was second to dried shrimps but superior to meat scraps or tankage (Fronda, Badelles and Padilla, 1934). For laying hens, fish meal ranked about equal to meat scraps, better than tankage, and a little inferior to shrimp meal (Francisco, Chan and Fronda, 1934). For ducklings and laying ducks, fish meal was observed to be better than snails but not so good as dried shrimps (Cruz, 1931).

Snails. Snails (*Vivipara angularis* Müller) are extensively used by duck raisers for supplying their stock with animal proteins. The abundance of snails in fresh water lakes on the shores of which duck raising flourishes makes this feed valuable in this industry. As a supplement in rations for laying hens crushed and cooked snails increased egg production (Frigillana, 1923). When fed to laying hens and ducks the egg production was greater with snails as a supplement than with copra meal. But when snails were given to ducks and ducklings the results were less satisfactory than with either dried shrimps or fish meal (Alcasid, 1919; Goseco, 1921).

Meat scraps. Meat scraps, a by-product in the meat packing industry are widely used to supply animal proteins in rations for live stock and poultry in foreign countries.

It was observed in this College in a ration for pregnant sows or suckling pigs, 5 to 10 per cent of meat scraps or dried shrimps were about equal in feeding value (Belandres, 1932; Villareal, 1932; Villaroel, 1932). But for chick feeding 20 per cent of meat scraps in the mash, and for weanlings, 10 per cent was better than tankage in the same amounts, but inferior to dried shrimps or fish meal (Fronda, Badelles and Padilla, 1934). For egg production, meat scraps ranked about equal to fish meal, superior to tankage, but not so good as dried shrimps (Francisco, Chan and Fronda, 1934).

Tankage. The feeding value of tankage has also been tested at this College. Weanling pigs on pasture and given sweet potato soilage, produced better results with tankage than with copra meal but not so good as with dried shrimps (Perez, 1932). For growing

chicks and laying hens, tankage was found to be an unsatisfactory supplement (Fronda, Badelles and Padilla, 1934; Francisco, Chan and Fronda, 1934).

Powdered buttermilk. Powdered buttermilk, a by-product extensively used as a supplement in rations for poultry in the United States, was found to be inferior to dried shrimps for chicks and laying hens. Powdered buttermilk in combination with dried shrimps, however, produced better results than either dried shrimps or powdered buttermilk used singly (San Pedro, 1934; Denoga, 1934).

OTHER SUPPLEMENTS

Cane molasses. Weight for weight, cane molasses at 20 per cent of the ration was found to be as efficient as corn for young growing pigs and breeding stock. For weanling pigs, molasses was found to be better than corn (Gochangco, 1933).

ROOTS

Cassava. Cassava (*Manihot utilissima* Pohl) is grown for its roots from which starch is obtained. A number of varieties of cassava are grown in the Islands, and of these it was observed that for pigs, when fed at 50 per cent of the ration, the following proved non-poisonous: Kapo White, Angular, Casjave Singkong Manis, Leyte Unknown, Rough Intermediate, Aipin Valenca, Mandioca Itaparica, Mandioca Basiorao, and Mandioca Tapicuru. The best results for swine feeding were obtained with Aipin Valenca; Mandioca Basiorao was second. Using the Kapo White variety at 5 per cent of the ration proved practical and economical; it was least efficient when incorporated at 20 per cent of the ration (Alba, 1934).

It was observed that on the basis of 3 parts cassava to 1 part corn, it is profitable to replace one-half of the corn with the cooked cassava in the ration of pigs on sweet potato pasture. In the absence of pasture, a greater portion of the corn may be replaced by cassava. Cassava proved equal, if not better, than sweet potato tubers and much superior to poñgapong. Cooked cassava, fed to pigs without roughage, was found to be as economical and have the same feeding value as corn. Raw, chopped, unpeeled cassava on the basis of 2 parts cassava to 1 of corn was found to be superior to ground corn (Mondoñedo and Bayan, 1927; Mondoñedo, 1928; Mondoñedo and Alonte, 1931).

Cassava refuse meal compared with fine rice bran was only 50 per cent as efficient when fed to young pigs 10 to 20 weeks old on grass pasture and with sweet potato soilage (Penuliar, 1933).

For chick feeding, cassava refuse meal was inferior to rice bran. A combination of cassava refuse meal and rice bran in equal parts, however, was used for chick feeding with fairly satisfactory results (Tabayoyong, 1934).

Sweet potato tuber. For pigs three months old and on dry lot, sweet potato tubers constituting 25 per cent of the ration compared favorably with cassava and was better than poñgapong (Mondoñedo and Alonte, 1931).

Poñgapong. Poñgapong, *Amorphophalus campanulatus* (Roxb.) Blume ex Deene root has some feeding value for pigs but proved inferior to sweet potato tuber, cassava roots or corn. The root was found to retain its itchiness even after cooking (Mondoñedo and Alonte, 1931).

FORAGE AND PASTURE

Corn fodder. Corn fodder is one of the most palatable forages for work bullocks, horses and goats. As a supplement to pasture for work bullocks it was found to be superior to sugar cane tops or Japanese cane and about equal to Guinea grass (Lago, 1919). For horses it is second in palatability to barit but better than Guinea grass, peanut hay or sugar cane tops (Tuya, 1930).

Guinea grass. For cattle, Guinea grass was more palatable than Napier grass, cogon or culape (*Paspalum conjugatum* Berg.) (Pepa, 1927). When fed to work cattle having access to rich pasture, however, Guinea grass did not give any advantage as a supplement (Lago, 1919; Sanchez, 1923). For horses, Guinea grass was of the same palatability as barit but better than Para grass, Napier grass, sugar cane tops or carabao grass (Tuya, 1930).

Sugar cane tops. For work bullocks, sugar cane tops were found to be inferior to corn fodder as supplement to common pasture, and less palatable (Lago, 1919). For horses, cane tops were found to be as palatable as Para grass, more palatable than Napier grass, culape or peanut hay and less palatable than corn forage, Guinea grass or barit (Tuya, 1930). For goats, cane tops were found to be medium in palatability (Suratos, 1933).

Calopogonium (*Calopogonium muconoides* Desv.) Whether as pasture or as soilage for swine, calopogonium was found to be inferior to sweet potato (Soriano, 1931). For young goats, it was medium in palatability, and for mature goats, poor (Suratos, 1933).

Sweet potato forage. As a supplement to corn, rice bran or copra meal, sweet potato soilage was found to be excellent for gilts on grass pasture. For weanling pigs, sweet potato pasture was superior

to sweet potato soilage, and for fattening pigs, it was observed to be slightly better than cowpea pasture and much better than mungo pasture (Rodriguez and Khomson, 1927). Pigs full-fed with rice bran, corn meal, copra meal and dried shrimps gave better results when allowed sweet potato pasture or soilage than when given calopogonium forage (Soriano, 1931).

A 52-ton silo for the preservation and storage of feed to be used in time of need.

While, in economy of gain, sweet potato pasture was 12 per cent less efficient than sweet potato soilage and 5 per cent less efficient than corn silage it was, however, better than either of the two on the basis of rate of gain (Barlaan, 1934). It was found that as much as 6,390 kgm. of sweet potato soilage may be harvested from

one hectare during the rainy season. The same area of this soilage can be depleted by 16 pigs in 74 days (Allas, 1934).

As feed for goats, sweet potato forage was found to be highly palatable (Suratos, 1933).

Cowpea pasture (*Vigna sinensis* L.). Pigs kept on cowpea pasture and fed corn alone as concentrate gained from 0.19 to 0.44 kgm. daily (Durham, 1915). With one-half the concentrate allowance cowpea pasture was 41.4 per cent more efficient than dry lot, and 14.17 per cent more efficient than sorghum pasture (Bautista, 1918). For fattening pigs, self-fed, self-choice, with corn, rice bran or copra meal in the self-feeders, cowpea pasture was as good as sweet potato pasture and much better than mungo pasture (Lago, 1924).

Native pasture. Work bullocks, if given enough time to graze, were found to do as well on good native pasture as when corn, copra meal or Guinea grass was given as a supplement (Lago, 1919; Sanchez, 1923). But cattle on pasture grass in the daytime and given a supplementary feed of molasses, copra meal and rice straw in the night produced better results than those on pasture alone. The supplements improved the carcass both in total dressed weight and in dressing percentage (Roces, 1934).

To maintain the pasture it was found that grubbing consistently gave larger yields of grasses than cutting. Cutting was, however, better than burning. In controlling weeds, cutting was the most efficient although the more laborious practice. A combination of cutting and burning was found to be best in producing feed and controlling the weeds (Pepito, 1934).

Miscellaneous forages. As feed for goats, it was observed that the leaves of acacia (*Samanea saman* (Jacq.) Merr.), aguiñgay (*Rottboellia exaltata* Linn.), and aurora (*Ipomea triloba* Linn.) were poor in palatability (Suratos, 1933). Barit (*Leersia hexandra* Sw.), a grass high in dry matter, ash and fiber, medium in crude protein, nitrogen-free-extract and fat, was found unpalatable for goats but very palatable for horses, being about equal to Guinea grass and better than corn forage and sugar cane tops (Tuya, 1930; Suratos, 1933).

Batadbatadan (*Andropogon halepensis* var. *propinquus* Kunth) fed to steers was as palatable as culape but less relished than Guinea grass and Napier grass (Pepa, 1927).

Butterfly pea (*Centrosema plumieri* (Turp.) Benth.) is a leguminous plant, therefore, rich in protein. It was found to be medium in palatability for young goats but highly so for the adult animals. Goats found the leaves of cacuate (*Gliricidia sepium* (Jacq.) Steud.) palatable (Suratos, 1933).

Cogon, *Imperata cylindrica* var. Koenigli (Retz.) Benth. ex Pilger was quite palatable for goats, but for cattle it was not so palatable as Guinea grass or Napier grass (Pepa, 1927; Suratos, 1933).

Culape or carabao grass (*Paspalum conjugatum* Berg.) was observed to be more palatable for horses than peanut hay but not so well relished as corn forage, Guinea grass, barit, sugar cane tops, Para grass and Napier grass (Tuya, 1930). When fed to cattle, it was as palatable as batadbatadan but inferior to Guinea grass and Napier grass (Pepa, 1927). For goats, it was medium in palatability (Suratos, 1933).

Goats did not find either culutculutan (*Urena lobata* Linn.) or dila-dila (*Elephantopus spicatus* Aubl.) palatable, but both young and old relished the leaves of ipilipil (*Leucaena glauca* (Linn.) Gaertn.) (Suratos, 1933). Feeding horses with ipilipil leaves was observed to cause the falling out of the hair not only of the mane and tail but of the body (Villegas, 1922).

Japanese cane when fed to work cattle as supplement to common pasture grasses was inferior to corn fodder (Lago, 1919).

Napier grass (*Pennisetum purpureum* Schum.) Napier grass is low in dry matter, crude fiber, nitrogen-free-extract and ash, and fair in protein, and fat. For cattle, it was found to be more palatable than culape or cogon, but less so than Guinea grass (Pepa, 1927). For horses, it was as palatable as sugar cane tops, more so than culape or peanut hay, but less so than corn forage, Guinea grass, barit or Para grass (Tuya, 1930).

Operculina turpethum (Linn.) was not relished by young goats but was by mature animals (Suratos, 1933).

Para grass (*Panicum barbinode* Trin.) was observed to be as palatable to horses as sugar cane tops, more palatable than Napier grass, culape or peanut hay, but less so than corn forage, Guinea grass or barit (Tuya, 1930).

Pulang puit (*Panicum colonum* Linn.) was very much relished by young and mature goats. It has low dry matter content (Suratos, 1933).

Among the standard forages tested, peanut hay (*Arachis hypogaea* Linn.) was the least palatable for horses. More of it was consumed, however, when it was cut in short lengths (Tuya, 1930). For goats it was found to be medium in palatability (Suratos, 1933).

Saguing butuan (*Musa errans* var. *botoan* Teodoro) is rich in dry matter and was found to be highly palatable for mature goats (Suratos, 1933).

Sorghum (*Andropogon sorghum* Linn.) as pasture crop for pigs is poorer than cowpea. But these animals on sorghum pasture fed one-half of the concentrate allowance were 23.88 per cent more efficient than those fed concentrates alone (Bautista, 1918).

Tuhod manok (*Synedrella nodiflora* Linn.) was not relished by goats (Suratos, 1933).

CORN SILAGE

Silage of the Yellow Flint variety of corn was found to have the following coefficient of digestibility with carabaos:

Dry matter	66.27	per	cent
Crude protein	51.81	"	"
Crude fiber	69.92	"	"
Nitrogen-free-extract	70.89	"	"
Fat	49.18	"	"

The amount of digestible nutrients contained in 100 kgm. of corn silage made from the same variety was found (Taleon, Villegas and Manahan-Ylagan, 1933) to be as follows:

Dry matter	20.36	kgm.
Crude protein	1.17	"
Carbohydrates	18.50	"
Fat	0.18	"
Total nutrients	20.08	"
Nutritive ratio	1:16.16	

For weanling pigs an economy of 11.43 per cent in the cost of feed was effected by the addition of corn silage to the concentrate. Corn silage produced even more economical gains than sweet potato soilage or pasturage. For older pigs, corn silage gave more economical gains than pasturage but less economical than soilage (Barlaan, 1934).

MINERALS

Common salt given *ad libitum* to cattle on the range was consumed at the rate of 11.6 kgm. per head yearly by Philippine cattle, 9.1 kgm. by the Nellores, and 10.1 kgm. by Herefords. It is advocated that from June to January salt be placed in salting boxes in small amounts because much moisture is absorbed by this mineral during these months. From February to May when salt absorbs relatively little moisture the animals may be supplied larger quantities of this mineral (Aldea, 1933).

Weanling pigs were more uniform, active, and vigorous, and ate their ration faster when given common salt at the rate of one per cent of the concentrate feed than when charcoal was used in place

of salt (Tugade, 1931). A mixture of one part by weight of common salt and one part corncob charcoal in the amount of 1.2 per cent of the ration did not improve the ration for weanling pigs on sweet potato pasture. The mixture, however, lessened parasitic infestation (*Ascaris* and *Oesophagostoma*) of the pigs (Cavillero, 1925). The same mixture fed at two per cent of the concentrate to pigs 22 months old and on sweet potato soilage proved better than when fed at one per cent (Tugade, 1931).

It was also found that a mineral mixture consisting of common salt, 40 parts, corncob charcoal, 40 parts, air-slaked lime, 18 parts, and copperas 2 parts was better than a mixture containing common salt, 40 parts, corncob charcoal, 40 parts, and air-slaked lime, 20 parts (Tugade, 1931). Sodium sulfate added to common salt and corncob charcoal did not improve the rate of growth of the pigs but improved slightly their feed consumption and was very effective in eliminating parasites. Calcium phosphate with common salt and corncob charcoal in the proportion of 1:2.2 proved better than sodium sulfate (Cavillero, 1925).

Nursing sows and suckling pigs on sweet potato soilage were benefited by the addition of 20 cc. of 2.7 per cent solution of potassium iodide in their ration. In the case of weanling pigs on good pasture potassium iodide was not necessary but the mineral was needed by pigs on dry lot (Tugade, 1931).

The animal property of the College of Agriculture consists of:

Horses	10
Cattle:	
Grades	67
Nellore	18
Holstein	3
Scindi	4
Carabaos:	
Grades	40
Indian	9
Swine	186
Sheep	15
Goats	35
Guinea fowls	19
Geese	12
Ducks:	
White Chinese	2
Muscovy	11
Chickens:	
Grades	49
Philippine	11
Banaba	32
Cantonese	622
Nagoya	67
White Leghorn	33
Barred Plymouth Rock	9
Rhode Island Red	42
Black Minorca	5
Buff Orpington	6
Silkies	4
Frizzles	1
Mikawa	15
Turkeys	15
Pigeons	112

THE FOOTHILLS OF MOUNT MAQUILING

The dormitories and Copeland Heights barrio nestle at the foot of Faculty Hill. Pili Drive borders the orchards of the Experiment Station. Baker Memorial Hall is partially hidden by the trees along Molawin creek.

SOME ASPECTS OF PHILIPPINE RURAL ECONOMY [1]

JOSÉ E. VELMONTE
Of the Department of Rural Economics

Rural Economics under an organized department became a part of the College Curriculum in 1919. The investigational work has been largely confined to farm tenancy, marketing of farm products, and farm standards of living as work in these fields seemed the most urgent. The limit of the fields of work was necessary to conform to number of workers.

FARM TENANCY

Farm tenancy is not normally a problem of new and undeveloped countries. Curiously enough we have such a problem in the Philippine Islands. The Census of 1918 reported that of the nearly 2,000,000 farms in the Islands, 22 per cent were operated under various forms of tenancy. This represented an increase of nearly 3 per cent over that of figures reported in the Census of 1903.

The existence and, worse, the increase of tenancy in the Philippine Islands is altogether unjustified. A liberal public land law was adopted in 1903 to promote ownership of land by individuals with little capital. Strict area limitations have prevented concentration of ownership and have proved effective bars to land ownership on a large scale by American and foreign corporations (Velmonte, 1928).

The only justification for the existence of tenancy is that it may be used as a ladder to farm ownership. From the results of a series of eight different and widely scattered surveys of farm tenancy (Hester, Mabbun et al., 1924) conducted in the provinces of Bulacan, Cagayan, Pangasinan, Cavite, Laguna, and Iloilo, and including a total of 830 tenants, it was shown that there was no indication that tenancy was a step to farm ownership. It was found that (1) the average age of the tenant for all surveys was 41 years and that age placed him beyond the prime of life; (2) the tenant class was a fixed caste, marrying largely within its class, and finally; (3) tenancy was found to be heavily weighted with debt which was usually passed from father to son, a condition which precluded any possibility for the tenant to start independent farming.

---

[1] General contribution from the College of Agriculture No. 422.

Surveys by the Department of farm ownership in which the steps that were taken by farm owners to achieve ownership were analyzed forced the same conclusion that farm tenancy was not one of the usual rungs of the agricultural ladder. (Cabrera, 1930) showed that of 389 farm owners surveyed in Pangasinan, only 3.3 per cent had worked as tenants previous to ownership. The usual agricultural ladder was found to have two rungs, a farm boy works with his father with no wages on the home farm and then on his father's death or in his later years he becomes owner of the land. It was further shown that of the various methods of attaining ownership, that by way of tenancy was the most difficult, taking the farmer the longest period before achieving ownership. (Malabayabas, 1931, and Bongato, 1933) arrived at the same conclusion that tenancy, while used by a larger proportion of farm owners of Laguna and Bohol as a step to ownership than by those of Pangasinan, was not the usual ladder to ownership.

The evils of tenancy as a form of land tenure are well known. That farm tenancy is not conducive to a development of sound rural life was shown in our surveys of farm standards of living in Cavite, Pangasinan, Tarlac, and Laguna (Bandong, 1929; Agbanlog, 1930; Meneses, 1932; Velmonte, Sumagui and Viray, 1934.) It was definitely established that tenant homes as compared with those of owners are always the poorest, devoid of even sufficient space for decent living, not to speak of the total absence of home conveniences and comforts.

It is generally understood that the public land law has very liberal provisions in so far as facilitating farm ownership among the citizens of the Philippine Islands. But the result of its operation for thirty years has revealed defects in the machinery of disposing of public lands which has been partly responsible for the comparatively small area taken as homesteads. In studies made of homesteaded regions in southeastern Tayabas (Layos, 1932) and Nueva Vizcaya (Danao, 1933) embracing a record of experiences of 203 pioneer farmers it was found that one who contemplates taking government land in those regions has to face many hardships, some of which are entirely beyond his own power to remedy. Some of these difficulties are: the slow and expensive method of clearing virgin land, the delays by the government in granting titles, lack of capital, and lack of roads. The seriousness of the land title situation is shown by the fact that of the 101 farms surveyed in southeastern Tayabas, only 12 had been patented. Government surveys were found to be slow, and action on final proofs for the perfection of titles of

homesteads were long delayed and this proved a discouragement to many settlers.

It is generally believed that an unjust contract is one very important cause of the permanency of tenancy in the Islands. (Hester, Mabbun et al, 1924) found the typical contract equitable and just. This conclusion was based on figures showing the relation of net income to investment of both landlord and tenant which showed the same return of 12 per cent for each party. This typical contract was applicable to 70 per cent of all tenancies surveyed. A later work (Bongato, 1933) covering 201 tenants of Bohol also showed that the typical contract was far from being unjust to the tenant as it is was found to even favor him in several respects.

The faults of Philippine tenancies lie deeper than the contract. Our studies show that the system of advances of money or commodities made by landlords at usurious rates with a lien on the tenant's share of the crop has worked in practice to keep the tenant in bondage usually throughout his life, precluding any possibility of his saving and accumulating capital and acquiring land and rising to the status of an independent farmer. As a measure to help solve the credit needs of the peasant farmer, rural coöperative credit associations have been organized in more than 500 municipalities of the Philippine Islands since the passage of the rural coöperative credit act No. 2508 in 1916. (Mabbun, 1930, and Arnaldo, 1931) from studies of the business operation of many associations revealed that the movement in general has failed to accomplish the desired results.

MARKETING FARM PRODUCTS

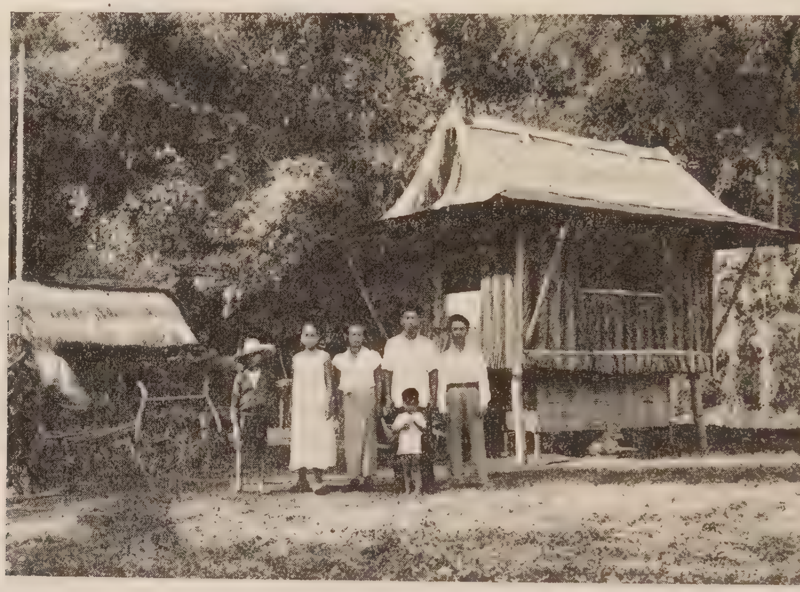
The abuses in the marketing of our principal crops have long been recognized and criticized, but they have not been corrected nor have the methods appreciably improved. Studies of the marketing of some of our principal products were undertaken in the Department with a view of showing the present methods followed.

One peculiar characteristic of the marketing of farm products is that it is largely in the hands of foreigners (Elayda, Lopez and David, 1926; Asuncion, 1932; Camba, 1932).

The marketing of rice has attracted very much more attention than any of the other crops largely because it is the staple food of the people. Faults have been heaped on the Chinese rice and palay merchants. (Asuncion, 1932) showed, however, that the margin taken by middlemen as measured by the difference between the price received by the farmer and the wholesale price in Manila was only 13 per cent. Within the limits of the survey, the facts seemed to

establish that the Chinese rice merchants are performing essential marketing services at a fairly low cost.

On the whole, however, there is much truth in the charge that the marketing of most of our farm products is notoriously full of abuses. Perhaps with no other crop is the farmer so much at the mercy of middlemen as in tobacco. (Elayda, Lopez, and David, 1926; and Mabunn, 1928) analyzed the evils of tobacco marketing in the Cagayan Valley and showed that the abuses of the middlemen were of the most outrageous kind. These investigators showed that competition among buyers was hardly known, and prices moved independently of economic laws. The channel of distribution was found



A home of a tenant and family living on an income of about ₱400 a year.

to be tortuous, leaf tobacco passing through three to as many as five middlemen before reaching the tobacco factory.

Madamba in a survey made in 1924 showed that Cagayan farm tenants received slightly less than 60 per cent of the wholesale price of leaf tobacco in Manila, and the margin taken by middlemen was over 40 per cent. And worse, Elayda, Lopez, and David in 1926 showed that the farmers of Cagayan and Isabela received no more than 33 per cent of the wholesale Manila price, and the middlemen's margin reached the unbelievably high peak of 67 per cent.

Abacá growers in Albay were found to fare slightly better in the hands of Chinese assemblers of fiber (Camba, 1932). Farmers

received for their 1930-1931 crop no more than 59 per cent of the wholesale price at Manila, with the middlemen taking 41 per cent.

Practically the same conditions were found in the marketing of copra and coconuts in Tayabas and Laguna (Mabbun 1930a, 1930b).

Coöperative marketing as the solution of the small farmer's marketing problems has become the constant cry. A survey by Mabbun in 1927 showed that while a coöperative association in Cagayan has improved prices for farmers yet the growth of the association was slow and farmer members were lacking in loyalty. Coöperative marketing in the Islands is still in the experimental stage and has yet to prove its worth in this country.

FARM STANDARDS OF LIVING

From the results of surveys of farm tenancies and peasant farm owners which are reviewed in this article, it is apparent that the average farm is far too small to support a decent standard of life for the farmer and his family. To support even the barest mode of living, the income from the farm often has to be supplemented by income from secondary occupations. Usury and the evils of the marketing system have reduced the farmer to dire poverty with debts that are often passed down from father to son and which in some cases with the most stringent economy and even with good crops he can hardly hope to pay. Under conditions like these there is little hope of making rural life happier, fuller of opportunity and more attractive.

Little has been done as yet in the Department in investigations on the standard of living on farms. Our work so far, embracing farm families in selected municipalities of Cavite, Pangasinan, Tarlac and Los Baños, shows that life on a peasant farm is one of great poverty, devoid of conveniences, comforts, and luxuries (Bandong, 1929; Agbanlog, 1930; Meneses, 1932; Velmonte, Sumagui, and Viray, 1934).

In one particular study (Velmonte, Sumagui, and Viray, 1934) of 240 farm families in four selected municipalities of Cavite, Tarlac and Pangasinan, an attempt was made to picture a standard of living on the farm near the minimum. It was shown that the average household consisted of about 6 persons and the total value of all goods used for one year was a little over ₱500. Peasant farm owners spent an average of about ₱580 annually per household while a tenant farm household live on a little over ₱400. It was found that with farms ranging in size from less than one hectare to not more than three hectares, it was not possible for a peasant farm family to maintain a standard of life above subsistence level.

[illegible]

[illegible]

THE INFIRMARY

The center for medical, surgical and dental treatment for the faculties, students and staffs of the College of Agriculture and the School of Forestry. The separate building housing the isolation ward, dispensary and pharmacy is beyond at the right.

OUR WORK ON PLANT DISEASES [1]

G. O. OCFEMIA
Of the Department of Plant Pathology

The founding of the College of Agriculture at Los Baños in 1909 gave birth to an agency destined to take a leading part in the study of plant diseases in the Philippine Islands through investigations along broader and more fundamental lines.

During the first seven years of the existence of the College of Agriculture there was very little work done on plant diseases. Herbarium specimens of fungi were collected in those years as part of the botanical collection, but it was not until the latter part of 1912 that what became a very extensive collection of Philippine fungi was started by Professor Charles Fuller Baker, then head of Department of Agronomy. This work was done by Professor Baker outside of office hours and at his private expense. Some of the more advanced students of the College also became active collectors of mycological materials. These specimens of Philippine fungi were sent for identification to various specialists in Europe, as, Saccardo, Sydow, Theissen, Diedicke, Rehm, Hennings and Patouillard. After their determination was received the materials were divided into sets of 100 different specimens and these were offered by Professor Baker for exchange as centuries of Fungi Malayana. It is needless to say that these specimens of Philippine fungi are of great importance and value because they form the basis of studies of fungous diseases of plants.

In 1914, three papers based on the specimens determined by European mycologists were published by Professor Baker. These papers were, (1) *The lower fungi of the Philippine Islands;* (2) *First supplement to the list of the lower fungi of the Philippine Islands;* and (3) *A review of some Philippine plant diseases.* In 1916, (4) *Additional notes on Philippine plant diseases* appeared in print.

Of the earlier works on plant diseases which were conducted by the more advanced students of the College of Agriculture, the field experiment to determine the minimum amount of Bordeaux mixture to apply in order to control the coffee rust caused by *Hemileia vastatrix* Berk. and Br. (Africa, 1918) was outstanding. This

[1] General contribution from the College of Agriculture No. 423.

study on coffee spraying with Bordeaux mixture which was published in 1918 was one of the earliest attempts at controlling a plant disease by protection conducted in this College. The result of this work is of great value to Philippine agriculture because it shows that the coffee rust, which ruined the coffee industry in Batangas Province, can be controlled profitably with the use of Bordeaux mixture.

THE BEGINNINGS OF EXPERIMENTAL PLANT PATHOLOGY

The basic work in plant pathology which involves the proof of the parasitism of organisms began in the latter half of 1916. Two years later, the first attempt at putting together all of the known diseases of economic plants occurring in the Philippines up to 1918 was made with the appearance in print of *Philippine economic-plant diseases* by Otto A. Reinking, first head of the Department of Plant Pathology. Some of the important diseases were discussed in detail in this paper, though many were only briefly described. The work included descriptions of symptoms, causes and methods of control of a great number of diseases of economic plants and was copiously illustrated. In addition to the valuable information on the diseases of plants known up to 1918, this publication served the additional purpose of presenting many unsolved problems that needed urgent attention.

ETIOLOGY OF COCONUT BUD ROT

In the earlier experiments at this College to determine the cause of the coconut bud rot in the Philippines, it was believed that the disease was caused by a bacterium, *Bacillus coli* (Esch.) Migula (Reinking, 1918). In 1919, after further isolation and inoculation experiments had been made, Reinking (1919) found that the cause of the infectious bud rot in Laguna Province is the fungus *Phytophthora palmivora* Butler (*Phytophthora faberi* Maubl.). It is now generally believed that there are two forms of bud rot. One of the forms is caused by bacteria and the other, the most infectious form, is due to the fungus, *Phytophthora palmivora*. Further work at the College of Agriculture has shown that the fungus *Phytophthora palmivora* also causes damping-off, rot and seedling blight of cacao, black rot of cacao pods and stem canker of cacao, canker of Para rubber, root rot and fruit rot of papaya, seedling and shoot blight of various species of citrus (Reinking, 1918, 1919, 1921; Ocfemia and Roldan, 1927) and seedling and shoot blight of quinine, *Cinchona* spp. (Celino, 1934).

As the knowledge of the nature and cause of a disease is very important because the choice and application of control measures

require that they be thoroughly understood, the proof of the etiology of coconut bud rot is one of the outstanding contributions in plant pathology by the College of Agriculture.

The study of citrus diseases furnished very valuable information concerning bark rot, gummosis and other diseases of citrus. Data on cost of spraying and time for applying protective materials to citrus orchards in order to insure the trees against fungous diseases were obtained. In addition to the useful knowledge regarding citrus diseases and their control, data on cost and rate of application of fungicides for the control of cacao diseases were secured (Reinking, 1918, 1921).

CAUSES AND METHODS OF TRANSMISSION OF BUNCHY-TOP OF ABACÁ AND FIJI DISEASE OF SUGAR CANE

Beginning in 1924 and continuing to the present time the activities of the Department of Plant Pathology, including those of the advanced students who prepared their theses in this department, have been of the same nature as the work on coconut bud rot. In practically all cases the objects were to determine fundamental questions relating to the nature, cause and spread of major diseases of leading Philippine crops.

Without putting aside the work on diseases of such crops as banana, coconut, cacao, avocado, mango, onion, rice, pineapple, sugar cane, tomato, pepper, and other economic plants, the main activity in plant pathology since 1925 has been centered upon the bunchy-top of abacá. In 1928, the study of the method of transmission of the Fiji disease of sugar cane, in order to throw light on its nature and cause, was added. In 1932, on account of the interest of advanced students in the problems, a study of certain phases of the mosaic of sugar cane was included in the research program.

Bunchy-top of abacá

When the work on the bunchy-top of abacá was taken up in 1925, there were several fundamental questions intimately associated with the disease that it was important to definitely settle. These questions were: (1) What is the nature and cause of bunchy-top? (2) Is the rotting of the roots, due to fungi and nematodes, the cause of bunchy-top? (3) Is abacá heart-rot a specific disease caused by a parasite? (4) As the fungus that causes the banana wilt is widespread in the soil in the Philippines does it cause heart-rot of abacá as claimed by some plant pathologists? (5) What organism is associated with cases of heart-rot of abacá in the field?

With these vital questions in mind the work on the bunchy-top of abacá was begun in April, 1925. Experiments were conducted under carefully controlled conditions to determine the cause and method of transmission of the bunchy-top of abacá. The insect-transmission experiments were conducted on specially constructed benches which were made proof against ants and other crawling insects (fig. 1). In order to be sure that the plants used in these experiments were free from the latent stage of the disease, abacá seedlings grown from seeds of different varieties, including variety hybrids, were

Fig. 1.—One of the wooden benches which was used in germination of abacá seeds and aphid-transmission experiments of bunchy-top of abacá. The seedlings on the right side of the bench are covered with cheese cloth to prevent aphid infestation. The covers of the four pots at the left side were removed to show the young abacá plants with early stages of bunchy-top. Note the leaf of the potted plant at the extreme left showing the chlorotic areas along the margin. (Photographed by the Photographic Laboratory of the College of Agriculture July 30, 1934.)

used. All the young plants used in the experiments and in the checks were covered with cheese cloth bags to prevent other insects from interfering with the work. In August, 1925 it was shown that the bunchy-top of abacá in the Philippine Islands is a virus disease and that it is transmitted in the field by the brown aphid, or plant louse, *Pentalonia nigronervosa* Coq. A disease is said to be caused by virus when the juice taken from the diseased plant contains some un-

identified infective principle. In some representative types of virus diseases this infective principle is capable of passing through filters that remove even the smallest known bacteria. An announcement of this result of insect transmission of the disease was published in *Phytopathology* in 1926, as a progress report.

From the results of the experiments at this College, it is evident that the rotting of the roots of abacá in advanced stages of infection with bunchy-top is due perhaps to starvation of these organs. Owing to the chlorosis and the narrowing and shortening of the leaves, they cannot manufacture the necessary amount of food that the lower organs need. According to this finding, the rotting of the roots is a result of the disease instead of a cause.

In 1927, the result of further work in this College was announced in the second progress report on bunchy-top of abacá, also published in *Phytopathology*. In this brief report of progress it was indicated that 11 to 17 per cent of the heart-rot cases in abacá fields in which bunchy-top is rampant are but results or final stages of bunchy-top. No claim, however, was made that all heart-rot of abacá cases are secondary diseases.

In 1928, experiments by one of the advanced students at this College conclusively proved that the nematode, *Heterodera radicicola* (Greef), causes root knot of abacá and not bunchy-top. He found that although *H. radicicola* may also cause bunching of the leaves of abacá, the veins of the leaves are not transparent as they are in the leaves of abacá attacked by the bunchy-top virus.

In 1930, the first paper of the abacá bunchy-top series appeared in the *American Journal of Botany*. This paper describes all the facts concerning bunchy-top of abacá known at that time. In the same year, another one of our advanced students (Leoncio, 1930) showed that the fungus *Fusarium oxysporum* Schlt. f. 3 Wr. (*Fusarium cubense* EFS.) that causes banana wilt, also causes wilt on young abacá plants which are grown from seeds. The reason that abacá wilt is not known in nature is that the disease is readily outgrown by fast-growing abacá plants.

In 1932, it was demonstrated by an advanced student that the *Fusarium* which may be isolated from certain field cases of heart-rot of abacá is *F. moniliforme* Sheldon var. *subglutinans* Wr. and Rkg. and not the banana wilt *Fusarium*.

In 1934, the results of further experiments on abacá bunchy-top were reported in THE PHILIPPINE AGRICULTURIST as the second paper of the abacá bunchy-top series. The conclusions arrived at in these further trials are: (1) The bunchy-top of abacá in the Phil-

ippines is caused by a virus different from that which causes bunchy-top of banana in Australia. (2) The bunchy-top of abacá virus in the Philippines does not infect Philippine varieties of bananas whereas in Australia bunchy-top is primarily a banana disease and its virus is capable of causing disease on abacá. According to this conclusion and for the protection of our banana industry, all possible effort should be made to prevent the introduction of the Australian bunchy-top of banana into the Philippines. (3) The virus of bunchy-top of abacá is not transmitted from the parent aphid vector to its progeny. This information is of importance in rehabilitation of completely devastated abacá fields because it assures us that when the virus-bearing aphids die their harm ends as there is no fear of their offspring transmitting the disease. These young aphids are infected only after feeding on volunteer abacá sprouts from infected corms. (4) The virus must remain in the body of the insect vector a period of 24 to 48 hours before it can be infective. (5) Bunchy-top of abacá cannot be transmitted by mechanical means as can the mosaic diseases. (6) Bunchy-top may be controlled by exclusion, eradication and protective measures. (7) A completely devastated abacá field may be rehabilitated if proper precautions are taken.

Mr. C. J. Magee, Plant Pathologist of the Department of Agriculture of New South Wales, Sydney, Australia and author of an exhaustive study of the bunchy-top of banana in that region, in referring to the writer's second paper of the bunchy-top of abacá series published in THE PHILIPPINE AGRICULTURIST wrote under date of April 24, 1934, in part, as follows:

> I had not previously seen your last paper dealing with attempts to transmit the disease (bunchy-top of abacá) to the Cavendish banana, and now think you have satisfactorily settled the question of the existence of a distinct banana and a distinct abacá virus. There is little doubt that our Cavendish is identical with yours, and this being so, the failure to obtain transmission to this variety indicates that you are not dealing with Banana Bunchy Top.

It is apparent that the work at this College on the abacá bunchy-top during the past nine years has been of a basic or fundamental nature because it clarified fundamental questions connected with the disease. In addition to proving that bunchy-top is caused by virus and that this virus is transmitted in the field by a plant louse, other diseases of abacá the symptoms, effects, and causal agents of which tended to be complicated with those of the bunchy-top were studied.

Transmission of the Fiji disease of sugar cane

The Fiji disease of sugar cane is one of the most important diseases affecting this crop in the Philippine Islands. Although the

existence of the Fiji disease has been recognized since 1910, nothing definite was known regarding its cause and method of transmission. The work in this College to determine the method of transmission of the Fiji disease was begun in 1928. In October, 1932, it was announced in THE PHILIPPINE AGRICULTURIST that in the College of Agriculture, the Fiji disease of sugar cane was successfully transmitted from diseased to healthy canes with the use of adults of the sugar cane leaf-hopper, *Perkinsiella vastatrix* Breddin (Delphacidae). The work was conducted in specially constructed cages which were made proof against all kinds of insects (fig. 2). The use of

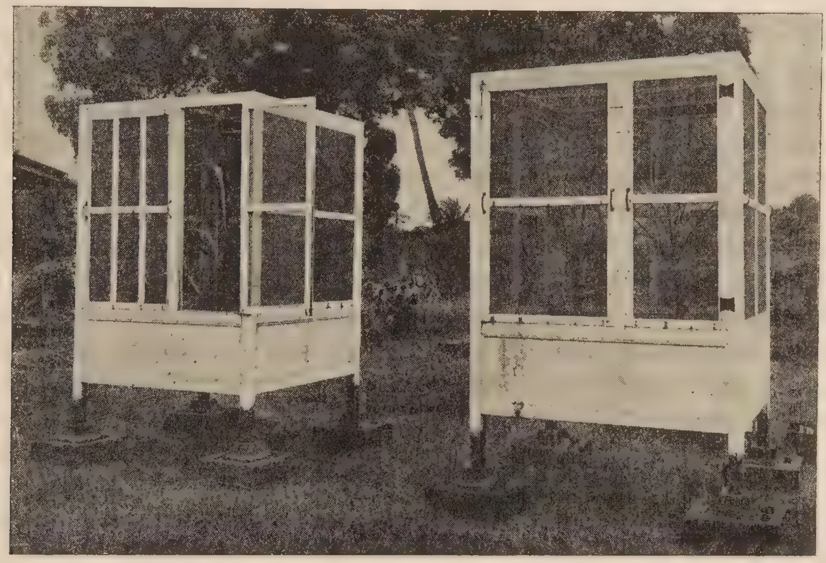


Fig. 2.—The insect-proof cages used in experiments on Fiji transmission. The one at the left was used as the "transmission chamber." In it were grown the experimental canes given odd numbers, along with the leaf-hoppers from Fiji-infected canes. The door of this chamber is open and the experimental canes inside the cage may be seen. In the one at the right were grown the control canes (even numbered), free from insects. (Photographed by the Photographic Laboratory of the College of Agriculture July 30, 1934.)

these insect-proof chambers together with the observation of important precautions and the use of one-node cuttings from single stalks of sugar cane proved beyond doubt that the Fiji disease is caused by a virus. It was further shown that the first and the most reliable symptom of infection of sugar cane with Fiji disease is the presence of galls on the lower surface of the leaves. The shortening of the leaves and stems takes place two to three weeks after the appearance of the first symptoms. The report of progress on the in-

sect transmission of the Fiji disease appeared in the March, 1934 issue of the *American Journal of Botany*. When Professor L. R. Jones of the University of Wisconsin received the manuscript of this progress report on January 25, 1933, he wrote us stating that the " . . . success in . . . proving the insect transmission of Fiji disease . . . marks another landmark in the understanding of this obscure group of diseases."

Mosaic disease and Fiji disease of sugar cane

In 1932, an interesting reaction of a sugar cane variety to grass mosaic was studied and described. According to the result of this work the shoots or eyes of sugar cane stalks affected with grass mosaic which appear to be free from the disease may have the virus in them. These shoots, however, that do not show symptoms of mosaic are tolerant to the disease. In other words the symptoms of mosaic are not shown because they are masked.

In 1933, experiments in collaboration with two thesis students demonstrated that the viruses of the mosaic disease and the Fiji disease of sugar cane are distributed throughout the stalks of infected canes. The germination of the eyes of infected canes representing different commercial varieties is not affected by these diseases in the same degree. Mosaic disease can be transmittd by pin pricks or mechanical methods but Fiji disease cannot. The experiments also confirmed earlier work that shoots arising from infected stalks of resistant POJ canes which appear to be mosaic-free contain the virus in the sap. But because they are masked the symptoms and effects of the disease on these shoots are not visible.

In commenting on the work of the Department of Plant Pathology during the past ten years, Dr. Otto A. Reinking, first professor and head of the department, wrote the author on February 22, 1934, from Berlin-Dahlem, Germany, in part, as follows:

> Your investigations on the various virus diseases have been very good and your contributions have been extremely useful. The Fiji disease work was new and of course of extreme interest to me. In going over the new investigations I find that many of the Philippine troubles have been gradually investigated in a basic form and I was so pleased to see that you and your students at Los Baños have been largely responsible for the basic work.

SUMMARY

During the first fifteen years of the quarter of a century of existence of the College of Agriculture, the study to determine the cause of coconut bud rot, the work on citrus diseases and the deter-

mination of the minimum application of Bordeaux mixture for the control of the coffee rust were the outstanding contributions.

From 1924 to the present time most of the research work has dealt with the bunchy-top of abacá, other diseases that tended to be in complication with the bunchy-top of abacá situation, and Fiji disease of sugar cane.

The work on the bunchy-top of abacá showed that the disease is caused by a virus which is transmitted by the aphid *Pentalonia nigronervosa.* The virus of the bunchy-top of abacá is different from that which causes bunchy-top of banana in Australia. The virus in the parent aphid cannot be transmitted to its progeny. The infective principle of abacá bunchy-top requires an incubation period of 24 to 48 hours in the aphid carrier. Bunchy-top of abacá may be controlled by exclusion, eradication and protection. A completely devastated abacá field may thus be rehabilitated.

The study of the Fiji disease of sugar cane showed in October, 1932 that the disease is also caused by a virus and that it is transmitted by adults of the sugar-cane leaf-hopper, *Perkinsiella vastatrix* Breddin.

The occurrence of shoots which appear to be free from mosaic disease in infected sugar cane stalks was found to be due not to uneven distribution of the virus but to masking of symptoms. This phenomenon is not shown by canes infected with Fiji disease.

In the Bureau of Forestry experimental plantation, covering 82 hectares on Mount Maquiling, among the introduced trees are *Amherstia nobilis, Hydnocarpus,* teak, mahogany, camphor and conifers of different species.

The potential utilities of disinterested research are unbounded and at first unmeasured. Therefore, though the most abstruse and theoretical science looks sterile, it is not. Likewise, snow-clad peaks and lofty ranges seem to be barrenness itself. Yet therefrom mighty rivers take their rise, and to their waters the rich lowlands partly owe their fertility.—L. Levy-Bruhl.

AT THE FOOT OF MOUNT MAQUILING

In the center are the Animal Husbandry buildings, with the pastures to the left. Above, beyond these buildings, is Faculty Hall. The School of Forestry is hidden in the trees above at the left. At the right, behind the Y. M. C. A. and two other dormitories is Copeland Heights, a student barrio.

OUR CONTRIBUTION TO THE KNOWLEDGE OF TROPICAL SOILS [1]

ROBERT L. PENDLETON
Of the Department of Soils

The soils work of this College, as a distinct branch of activity, was not started until about a decade after the founding of the institution. A separate Department of Soils was not established until after another decade had passed. Dr. E. B. Copeland, the founder of the College, with rare discernment, realized at the beginning that the knowledge of tropical soils and particularly of Philippine soils was so extremely limited that a separate department had not been warranted. Unfortunately it is still true that, particularly in proportion to the importance of the subject, there is yet a distressing paucity of exact knowledge of tropical soils. On the other hand, that very lack of knowledge, and the whole field still before us, makes the subject stimulating and keeps it vitalized.

Although the study of soils as a separate activity was not commenced until long after the College was well established, in the Agronomy Department, very soon after the opening of the institution, experiments were undertaken on the effects of various fertilizers on important local crops, and during these early years real contributions were made to the knowledge of the fertilizer responses of some crops on our Campus soils. Unfortunately, the work was fragmentary, and never rounded out into an adequate whole. Contributions to the knowledge of the nutrition of crops, particularly of rice and coconuts, were made through the study of solution culture effects in the Department of Plant Physiology. The Chemistry Department, in addition to the analyses of soils, has definitely contributed to the knowledge of nitrogen transformations, particularly in rice soils. These were good beginnings, and to some degree helped in the orientation of work at the time the Soils Division commenced activities.

It is, perhaps, fortunate that in the early years of the College, soil studies as a major branch of the College activities were not established, for had they been, they would almost certainly have been developed along lines now antiquated, lines which we now know to

[1] General contribution from the College of Agriculture, No. 424.

be much less profitable in telling us of the real nature of the soil than recently developed lines of research. For, in the period when the College was founded, it was not generally realized that the older style conventional "soil analysis" of "samples" was almost entirely a waste of money and misleading in results.

While the older style "analyses" were not done by the College in quantity, neither had the field studies been given the attention that they deserved. Even today there are vast regions of the Philippines that have never been visited by a pedologist, much less studied or mapped, even on a reconnaissance scale. Hence it is that on our Campus, soil science as such is still very young; furthermore the very limited knowledge of Philippine soils prevents our doing what we otherwise should be able to do, in contributing our share to the building of an adequate foundation for the agriculture of the Islands.

The real beginning of our present activities in the study of soils in the College was in 1923. The situation at that time was something as follows: (1) There was a modest stock of equipment for the "conventional" and often "worn out" methods of studying soils in the laboratory. (2) There were entirely inadequate means for the instruction of the students, either in the class room, the laboratory, or the field, because of the lack of knowledge of Philippine soils, lack of personnel to direct the work, lack of equipment in any adequate quantity, and lack of laboratory space. (3) There were many students waiting to complete the required course in soils. (4) There were no adequate textbooks suited to our tropical soil conditions. (5) There had been practically no soil survey of the Islands. This last was and is especially unfortunate, for it not only deprived us of any adequate source of information about the soils of the Philippines, but also meant that there was not the professional market for the services of students who might major in soils; hence we failed to attract for major work in soils our share of the more able students of the College.

In the face of this situation, some of the results of our attack may be given: (1) Thesis students have endeavored to map the soils and measure the characteristics of more important soil types accessible to us here on the Campus. Most of the problems have been in the field. Since in a forthcoming series of papers, the nature and accomplishments of our thesis work, as embodied in about fifty unpublished theses, will be taken up in considerable detail, the nature of this work will be but very briefly mentioned here: (*a*) The irregularity of the subsoil conditions and their relation to drainage and other economic problems of our experiment station soils was

demonstrated by several studies in which closely spaced borings were made, and profiles along roads and railways intensively studied. (*b*) Soil erosion problems were early attacked, and as far as our crude equipment indicated, for at least some soil and cover conditions, erosion was surprisingly slight. (*c*) Intensive soil surveys have been made of the region surrounding the Campus and Mount Maquiling. (*d*) Physical studies, according to newer methods have been made of many of the soils in the Maquiling region. (*e*) Relating to the soils of these surveys, determinations of pH, nitrogen, phosphorus, nitrates, etc., have been made in large numbers. (2) The staff have

Robert L. Pendleton

Fig. 1.—The field is our principal laboratory. Students and faculty of the Soils Department spend much of their time making soil surveys and mapping the soils. A party of thesis students mapping Kapatagan Valley.

made for commercial and for government entities other than the University, soil and drainage surveys in various parts of the Islands, particularly in the Silay-Saravia and La Carlota districts, Occidental Negros; the San José district, Mindoro; Barotac Nuevo, Panay; Calamba district, Laguna; the Southern Ilocos region, La Union and Ilocos Sur; for the Philippine Sugar Association, a reconnaissance soil survey of Occidental Negros, including the districts of Manapla, Victorias, Talisay-Silay, Bacolod, Ma-ao, Binalbagan, Isabela, and Kabankalan. The appreciation of the value of this

work was shown in the defraying by the various organizations of all the field and publication expenses incurred in this work. For the Bureau of Education, surveys have been made of soils in Muñoz, Nueva Ecija, and Trinidad, Mountain Province. For the Bureau of Plant Industry, of the soils of Kabakan and surrounding country, Cotabato; for the Bureau of Forestry, of the Bokakeng project, Baguio, Mountain Province. Other studies and surveys, which have been made as a part of our own research studies, are not included in this list. These field studies have been of great value in providing material for instruction and demonstration. (3) For the important field of soil erosion and conservation, hardly a beginning has been made, partly because of the inherent difficulties and partly because of the heavy expense which it would entail.

Results of the activities of the Department of Soils: (1) We are gradually developing a knowledge and philosophy of the soils of the Islands, as a background for the particular conditions which need study. This knowledge, combined with our constantly increasing knowledge of the nature of tropical soils in other and neighboring regions, is proving of inestimable value in the attack upon our soil problems. (2) For the commercial concerns that have generously defrayed our expenses in our surveys for them, these studies have been and are of definite value. (3) The confidential reports which we have made for the non-official parties provide rich materials for instruction and research. (4) A large collection of photographs, maps, samples, and other research and teaching material has been accumulated. (5) We are writing manuals and other text material applicable to our conditions, though none of our manuals have yet had sufficient use in the class and laboratory to justify putting the books into print. A manual for soil microbiology and a soil survey manual are the most important of these. While there are manuals for soil microbiology designed for temperate soils and conditions, there is no known soil survey manual in print in any language. (6) Translations for the use of our students have been made from the Dutch, since tropical soil science in the Netherlands Indies is particularly well advanced. One of these translations, issued by our College in mimeographed form, and subsequently by the National Geological Survey of China in formal book form, has had the unusual distinction of being placed among the ten leading books presenting modern conceptions of the development of soils, particularly in the humid tropics. (7) The interest in soil studies, which has resulted in part from our work, promises to assist materially in a more active study and survey of the soils of the Islands. (8) One

Fig. 2.—The soil survey map of the La Carlota area, Occidental Negros. A map of the soils in an important sugar cane district, a practical result of the study of Philippine soils.

of the incidental results of our agitation for better maps and the coördination of existing mapping activities in the Philippines was the establishment some years ago of the Insular Map Board by Executive Order of the Governor General.

Directions in which the Soils Department is assisting in agricultural and forestry progress in the Philippines: The soil is the greatest single natural resource, particularly of these Islands, for both forestry and agriculture depend directly upon it. Improper handling of soils, especially the cultivation of recently cleared forest soils, often leads to tragic results in decreasing fertility and rapid soil destruction. The Bureau of Forestry, realizing this, has sought our coöperation in studying these problems. We are also endeavoring to give them assistance in the difficult problems of land classification, but are handicapped through inability to get into the field to the degree necessary. We are also coöperating with that Bureau in studies of the utilization and rejuvenation of cogon and other waste lands, a very pressing problem. Several papers have recently been published on this question. We still await the perfection of arrangements for the development of an Archipelago-wide soil survey, which will be the most important way in which we can be of direct assistance in meeting and solving the problems of the agricultural industries.

In the meantime, our study of the unsurpassed variety of geological, climatic and biological conditions as related to the soils of these Islands presents to us a rare opportunity for a thorough scientific study of tropical soil formation and development, so that with increasing opportunities in these Islands for exploration and soil surveys we may be able to make a greater and more valuable contribution to this subject. An epoch-making book dealing with tropical soil forming processes, now being published in Holland, is in the process of being translated into English in the Soils Department; this work will be of great value both to us here in understanding our soil formation and nature, and to the very great majority of pedologists in the world who do not read Dutch. Our soil microbiology division, while having added to the understanding of the nature and extent of the nitrogen transformations in forest and agricultural soils, has still a vast field before it in elucidating the stages and importance of the nitrogen cycle in our Philippine soils.

Therefore, while the research which has been conducted upon soils of the Philippines, both upon the Campus and in the field surveys in the vicinity of the College and in many other parts of the Philippines, has received recognition scientifically and commercially, and

while our publications, including the translations from the Dutch, have been favorably received by pedologists in widely scattered parts of the world, yet our work is really only well begun—the seed-time has passed, the cultivation is progressing, but the time for the harvest has not yet arrived. Soil research here, because of and in spite of its youth, has a wholesome start along lines of very great promise, scientifically and economically. While the accomplishments of pedology here are as yet small compared with what they may reasonably be expected to be in the future, the results are real. Granted reasonable support and absence of catastrophe, soil research gives promise of much greater returns in the near future.

Many excavations upon the College Campus indicate that more than once in the past there have been violent volcanic eruptions in this neighborhood, with showers of hot pumice stone, ashes and mud flows overwhelming and burying the soil often meters deep. Centuries passed and soil formed from the ash. Again an eruption, the country laid waste and the soil buried. Those eruptions were far more violent and came from a point nearer the Campus than the last one, in 1911, of Taal Volcano, which lies about 30 kilometers to the southwest. That eruption was as nothing compared with the hundreds of former eruptions of Taal, Maquiling, Malarayat, Banahao, San Cristobal, and the unnumbered smaller craters and cinder cones that dot southwestern Luzon—eruptions which altogether have ejected *hundreds* if not thousands of *cubic kilometers* of lava and ashes. While no one knows nor can predict whether any of these volcanoes will again erupt, a geologist recently visiting the Campus mentioned the general rule that as long as a volcano still retained its crater more or less intact there was a possibility that an eruption *might* still occur.

Ages and cycles of nature in ceaseless sequence moving.

—ARISTOTLE.

COPELAND HEIGHTS AND MOUNT MAQUILING

Behind the two College dormitories, hidden amongst the bananas, are the homes of many of our students; houses built by the students principally from locally available materials.

WHAT AND WHEREFORE [1]

EMMA S. YULE
Of the Department of English

One of the advantages of pioneer work is that to a considerable degree one can lay out plans unhampered by what has been done by predecessors. True, there are contemporaries and there is relativity, but these restrictions are of gossamer texture, comparatively.

In what may be called the sowing season of this College the prime question facing the English department was *what* to teach. The subject, English, in any curriculum where it is the language of instruction, is fairly comprehensive and in spots intensive. But in an institution, such as this College, where science is dominant and the time alloted to English in the curriculum was squeezed to the minimum the subject is so restricted that the choice of *what* to teach becomes of vital import.

In choosing, the student's need in his life work was the first consideration. To meet this need, the aim was limited to teaching the students, so far as possible, to speak, read and write in the English language within the scope of their elected calling. It was believed, that they that go afar from cities and dwell on farms, that labor with plants and animals, these should know the rules of grammar and the wonders of words. The study of literature was not considered except to offer tidbits to "foster appetite". Such delectable composition as narration, except the most elementary, description involving such raptures as a waterfall, a moonrise, not to mention verse writing was pushed aside. To become familiar with the vocabulary of farming and the telling about farming and later about the basic sciences of farming—this was the material, this the aim of the English work in the classroom. Nor is such material dull, monotonous if the teacher follows Prospero's aim in his teaching of Caliban and endows the student's purposes with words by which he could later make them known.

In time, with readjustments and revisions, three elective courses in English were added. In choosing and planning these courses the student in his life work was still kept in mind. His possible environment and duties as a citizen were consistently, insistently and persist-

---

[1] General contribution from the College of Agriculture, No. **425**.

ently kept to the fore. It was recognized that many of the students when they can say, "Man am I grown, a man's work must I do" will be called upon to explain in everyday words, instead of the words of the lecture room, the thesis or the bulletin, about plants, their needs and their troubles and various other things that torment and worry the tiller of the soil. Such explanations are not easy. Else why did Barrie say, "The man of science appears to be the only man who has something to say just now, and the only man who does not know how to say it." So, to help the student get ready for this probable duty, a little training in translation of the language of science into ordinary speech is given in one elective course. Agriculturists have to defend their principles quite often in their fight for better farming,—so it was decided that a little work on the principles of argument might be helpful. Also, agriculturists have to transact business by correspondence, write reports and similar documents. These tasks require "skill with words to make them known". One short elective course offers some training in this type of expression. No man should more carefully select his personal non-technical library than a farmer. A survey of the literature of the world will help him to choose "the precious life-blood of the master spirits"—and also to learn "to feed on dainties bred in books", and not waste his substance and his time on some of the vast amount of ephemeral printed matter listed as books. Such a course is one of the electives.

Briefly this is the *what* and the *wherefore* of the catalogued work of the English department.

One of the pleasurable duties of the department has always been the reading for English of the theses presented by the seniors. By the early medieval period of the department, considered historically, the idea had seeped into the writer's consciousness that thesis writing, that is structure and a few other major points, should be incorporated into the English work, for from the viewpoint of composition many theses were without form though not void. By one of those favorable strokes of fate, Dr. Sam F. Trelease was on the faculty at that time and Editor of *The Philippine Agriculturist*. In his editorial capacity he was having his worries over formless papers. He and the writer, who was assistant editor, had many sputtering sprees which eased impatience. The sputtering was not all noise. For soon the sputterers for months spent much of what was scheduled as their leisure time in evolving rules and schemes for preparing technical papers such as theses. Doctor Trelease, eminent botanist that he is, is also a born editor—as his present position as editor of *The American Journal of Botany* is evidence—so he did the form

evolving and the writer did the testing in the classroom. Gradually, a practical manual "Preparation of Scientific and Technical Papers" took shape such that Williams and Wilkins Company would and did publish it. It is no vain boast to say that this little book has met the need which called it into existence. To this statement every thesis adviser on the faculty will make affirmation.

It was early recognized that the department could increase its usefulness practically by becoming a first aid station for Filipino faculty members and students not in English classes who might stumble a bit over a verb or trip over a preposition or a connective. In taking a backward glance on this anniversary over this service it is a matter of profound satisfaction to know that various forms of aid have been and are daily asked for, from letters to "her" to papers on subjects of many types, and for diversion for the department, verse, stories and drama. One thing the depression has not hit has been this special and specially loved first aid work. They also teach who serve.

In giving further service the department has organized and sponsored Campus activities of a cultural nature. A dramatic club has given many students some training not only in acting but also in presenting plays. The *wherefore* was that the student could use this valuable vehicle, the drama, in teaching or establishing new ideas in agriculture in rural communities, and also by directing simple plays of a literary nature add to the culture of the people.

"Doctor Research to the Rescue" a bulletin or circular solely devoted to dramatic presentation of unfamiliar technical truths about agriculture was written, under the supervision of the department, by students and graduate assistants and presented under the direction of this club. Although this work was issued seven years ago, calls for copies still come to the office.

Training was given a large group in presenting local history dramatically by "The Pageant" produced as part of the twentieth anniversary celebration in 1929. And again, by a pageant showing the progress of the College, presented as part of the twenty-fifth anniversary, training was given a large group of students.

That vital factor in giving enjoyment and promoting unity in a locality, community singing, was fostered to quite a degree, for a number of years by the department through the weekly College Sing. This activity, woeful to state, owing to a depleted staff is now temporarily inactive.

While the department has no contribution to research to its credit it has rendered vital service to the country by aiding in mak-

ing the spread of the product of the scientific departments possible. In addition to teaching expression of thought, effort has been made, even with the limited time given, to widen the interests of the student and to make him better equipped to give of his knowledge to fellowmen. The results of the service cannot be tabulated; judgment should be on the endeavor.

SCIENCE

PILOT OF INDUSTRY, CONQUEROR OF DISEASE,
MULTIPLIER OF THE HARVEST, EXPLORER OF THE UNIVERSE,
REVEALER OF NATURE'S LAWS, ETERNAL GUIDE TO TRUTH

Carved on the National Academy of Sciences and the National Research Council Building in Washington D. C.

Robert L. Pendleton

TALIM ISLAND IN LAGUNA DE BAY

Beyond the regular Experiment Station fields, beyond the coconuts of Maajas and of Mayondon, out across the lake stands Talim, against the ruggedness of the Sierra Madre.

Contribution of the College of Agriculture to the Filipinization of Government Technical Services

COLLEGE OF AGRICULTURE ALUMNI

BUREAU OF SCIENCE

- EDUARDO QUISUMBING — *Botanist*
- BASILIO L. HERNANDEZ — *Asst. Chief, Scientific Library Division*
- ANDRES M. NONO — *Field Inspector, Malaria Control Investigations, Rockefeller Foundations*
- FIDEL DEL ROSARIO — *Asst. Scientist*
- DOMINADOR Z. ROSELL — *Junior Chemist, Division of Soils and Fertilizer*
- GERONIMO L. FLORES — *Asst. Scientist*
- ELENA M. CAGUICLA — *Scientific Assistant*
- AMADO A. SANTOS — *Junior Scientist*
- FELICISIMO B. SERRANO — *Scientist*

FIBER INSPECTION SERVICE

MANILA
- VICENTE C. BARTOLOME — *Chief Fiber Inspector*
- EMILIO R. FELICIANO — *Fiber Inspector*
- ELISEO V. HERNANDEZ — *Fiber Inspector*
- GABRIEL O. LACUESTA — *Fiber Inspector*
- ANTONIO LEJANO — *Traveling Fiber Inspector*
- AGUSTIN J. MEJIA — *Fiber Inspector*
- ABUNDIO E. MOJICA — *Asst. Fiber Inspector*
- PETRONILO NISPEROS — *Apprentice Fiber Inspector*
- FELIX A. PADLAN — *Apprentice Fiber Inspector*
- JOSE R. MOZO

LEGASPI, ALBAY
- SOTERO F. ALBANO — *Chief Fiber Inspector, Port of Legaspi*
- PASTOR V. MACLANG — *Fiber Inspector*
- SERAPIO R. VENTURA — *Fiber Inspector*
- PAULINO M. UNGOS — *Apprentice Fiber Inspector*

CEBU, CEBU
- PABLO J. HAUTEA — *Fiber Inspector*
- HILARIO T. RAMOS — *Fiber Inspector*
- FERNANDO REYES — *Fiber Inspector*
- JOSE C. REYES — *Fiber Inspector*
- MARIANO F. VILLARAZA — *Fiber Inspector*
- LUCIO Z. BLANCO — *Apprentice Fiber Inspector*
- SOTERO P. LANTICAN — *Apprentice Fiber Inspector*
- URBANO C. MANABAT — *Apprentice Fiber Inspector*
- TARSILO ROMERO — *Apprentice Fiber Inspector*

DAVAO, DAVAO
- BENJAMIN C. CABAILO — *Fiber Inspector*
- MAXIMO E. PEPA — *Fiber Inspector*
- NORBERTO A. RIVERO — *Fiber Inspector*
- TEODORO M. VELASCO — *Fiber Inspector*

- MATIAS P. SUCALDITO — *Apprentice Fiber Inspector*

BUREAU OF PLANT INDUSTRY

ADMINISTRATION
- MANUEL L. ROXAS — *Director*
- JOSE CAMUS — *Asst. Director*

CHIEFS OF DIVISIONS
- HILARION S. SILAYAN — *Chief, Agric. Extension*
- GONZALO MERINO — *Chief of Plant Sanitation*
- F. Q. OTAÑES — *Actg. Chief of Plant Sanitation*
- FELIPE T. ADRIANO — *Actg. Chief, Agric. Chemistry and Soil Technology Laboratory*
- TORIBIO VIBAR — *Chief Agronomist*
- MARCELINO CONSTANTINO — *Asst. Chief, Div. of Plant Propagation*

CHIEFS OF SECTION
- VICENTE C. ALDABA — *Chief, Fiber Research Sect.*
- SEVERO MARQUEZ — *Chief, Plant Quarantine Sect.*
- DOMINGO B. PAGUIRIGAN — *Actg. Chief, Tobacco Section*
- FRANCISCO D. MARQUEZ — *Asst. Chief, Agric. Extension*

AGRONOMISTS
- VICTOR C. ALDABA (*Dist. Agron.*)
- FRANCISCO GALANG
- PAUL A. VILLYAR

ASSISTANT AGRONOMISTS
MOISES SANTIAGO, CORNELIO CRUCILLO, JULIAN A. AGATI, B. M. AGUANTA, VICENTE ALLAREY, PASCUAL A. ALMAZAN, JOSE D. BAGARINO, BASILIO R. BAUTISTA, CATALINO T. BULIGAN, JUAN B. CABANOS, MELANIO R. CALINISAN, TOMAS COLLADO, EUGENIO E. CRUZ, PEDRO I. CRUZ, LEONCIO DARIO, ANTONIO DERECHO, JUAN M. EJERCITO, ANIANO ELAYDA, ABELARDO FAJARDO, JUAN B. FANDIÑO, LAUREANO G. FERRER, CATALINO E. GARCIA, SALUSTIANO S. GONZALES, PEDRO HERNAIS, RUFINO A. ISIDRO, FRANCISCO DE JESUS, MARIANO JURADO, EPITACIO A. LANUZA, FELIX D. LAZO, TROADIO T. LEGASPI, VALENTIN K. LINA, AMBROSIO M. LONTOK, FELIX N. MACEDA, ULPIANO V. MADAMBA, RAMON V. MANIO, EMILIO K. MORADA, VICTORIO R. OLAN, SALVADOR B. OLIVEROS, BONIFACIO PADILLA, GAUDENCIO PALAFOX, PABLO QUIZON, JOSE C. RAMOS, FRANCISCO R. RED, FELIXBERTO RELOVA, SIMON A. REYES, PEDRO A. RODRIGO, MAURO G. RODRIGUEZ, LEON M. ROMERO, GREGORIO SANTOS, PEDRO L. SISON, SIXTO L. SISON, APOLINAR TALENTO, PRIMITIVO TUGADE, JUAN O. UNITE, ARSENIO VIVENCIO, EUSTACIO S. VILLANUEVA, GAUDENCIO ZABELLA, ELADIO E. ZABLAN

JUNIOR AGRONOMISTS
MARCOS DE LA CRUZ, SEVERINO B. ETORMA, PEDRO Z. MADRID, JUAN P. MENESES, JUAN O. SUMAGUI

PLANT PATHOLOGISTS
FELICIANO M. CLARA, MACARIO A. PALO (*Asst.*), GAUDENCIO M. REYES, NICANOR G. TEODORO

PLANT SANITATION FOREMEN
LUIS ALDEA, DIOSDADO S. BONGATO, PEDRO D. COLLADO, IGNACIO O. DRES, EVARISTO A. HURTADO, FELICISIMO S. MACEDA, GABRIEL MALABAYABAS, JULIAN R. MARTINEZ, JOSE L. MORALES, GUILLERMO O. PALIS, ADRIEL A. PALMA, PANTALEON DE LOS REYES, HILARIO D. SICAM, LORENZO N. TALATALA, PASTOR VILLANUEVA

- JOSE DE LEON—*Horticulturist*
- JUAN P. TORRES—*Plant Breeder*

SUPERINTENDENT OF STATIONS
- CORNELIO BALANGUE — *Curing Sheds, Ilagan, Isabela*
- MARIANO E. GUTIERREZ — *Ilagan Tobacco Station*
- FERNANDO D. LUISTRO (*Actg. Supt.*) — *Maridagao Rubber Station*
- FRANCISCO P. OCTUBRE (*Actg.*) — *Maligaya Rice Station*
- FELIPE PADOLINA (*Actg. Supt.*) — *Lamao Hort. Station*
- PEDRO L. PAULINO (*Actg. Supt.*) — *Gandara Seed Farm*
- JOSE P. TAN (*Actg. Supt.*) — *Lipa-Coffee-Citrus Station*

BUD-ROT INSPECTION
- FILOMENO L. BUTAC — *Bud-Rot Inspector*

FIBER RES. ASST.
- BUENAVENTURA C. BRIONES — *Fiber Research Assistant*

LABORATORY HELPERS
PURIFICACION CAGUICLA, FELIPE E. CRISOSTOMO, EMILIA ODJIAR, SALVADOR PADILLA, FELIX PAGUIA, CAYETANO RAMOS, DOMINADOR S. SANTOS, DEMETRIO P. TABIJE, ENRIQUE R. VILLANUEVA, HONORIO L. YLIZALDE

HELPERS
FELIPE CORTES, JUAN P. TECSON, SILVINO HERNANDEZ, JULITO MARCOS, PONCIANO ORTIZ, ARCADIO QUERIJERO, JULIAN ROXAS

BUREAU OF EDUCATION

BANGA RURAL HIGH SCHOOL
AGAPITO E. BUENAVENTURA (*Prin.*); JULIAN B. BELO (*Teacher*); ANTERO INCIONG "; ANASTACIO ROWAN "; ALBINO VIDAL "

BATAC R. H. S.
JOSE CRISANTO (*Principal*); CATALINO ACOSTA (*Teacher*); DAVID M. CABRERA "

INDANG R. H. S.
BASILIO O. VIADO (*Principal*); ALFREDO PABLO (*Teacher*); MIGUEL R. OCAMPO "; FRANCISCO PANGANIBAN "

CAM. SUR AGRIC. H. S.
ZOSIMO MONTEMAYOR (*Principal*); POLICARPO CALMA (*teacher*); MELQUIADES BAYOG "

BUNAWAN AGRIC. H. S.
EULOGIO M. ACUÑA (*Principal*); FILEMON ESPAÑOL (*Teacher*); ENRIQUE PALLER "; FELIX SUMAGUIT "

BILAR R. H. S.
JUAN G. PAGSOLINGAN (*Principal*); CASEMIRO DE SAGUN (*Teacher*); QUIRINO RICAFRENTE "; CEFERINO VILLANUEVA "

NVA. VIZCAYA NEW VOC. & R. H. S.
ELIAS M. CARAY (*Principal*); IGNACIO E. CARULLA (*Teacher*); PANTALEON L. DUMLAO "; CORNELIO R. GALLARDO "; TIMOTEO M. RAYRAO "; TOMAS DADUFALSA "

BUKIDNON AGRIC. H. S.
FELICISIMO OBIAS (*Actg. Principal*); MAGDALENO M. CAGUICLA (*Teacher*); SIMEON ROYECA "; ANGEL R. RELIS "

MAMPISING AGRIC. H. S.
ELIGIO C. URETA (*Principal*); EUGENIO CELIS (*Teacher*); PORFIRIO E. JAIN "

PAMPANGA AGR. SCH.
FELIPE O. CEVALLOS (*Principal*); GREGORIO D. ALBINO (*Teacher*); SANTIAGO MEDRANA "

ZAMBALES R. H. S.
CAMILO GUEVARRA (*Principal*); ALFONSO T. ASUNCION (*Teacher*); JOSE L. DIMAANO "

ODIONGAN R. H. S.
NICOMEDES C. FLORES (*Principal*); SIMPLICIO FESTIN (*Teacher*)

PIAT R. H. S.
SEVERINO R. SANTOS (*Principal*); SALVADOR T. PACION (*Teacher*)

ILAGAN R. H. S.
FRANCISCO C. BERNARDO (*Principal*)

ECHAGUE R. H. S.
CEFERINO L. MAGNO (*Teacher & F. Mgr.*); CESARIO C. BANDONG "; CONSTANCIO T. MEDRANA "

LAGANGILANG AGRIC. H. S.
VICTORINO C. LOPEZ (*Teacher & F. Mgr.*); PERICO Y. ARCEDO "

CENTRAL LUZON AGRIC. H. S.
JOSE M. SAN JUAN (*Teacher*); NAZARIO SADORRA "; IGNACIO R. ANG "; DOMINGO G. ANIOAY "; SALVADOR F. BOLIVAR "; DIMAS MAULIT "

ABORLAN AGRIC. H. S.
JOE R. HAYNES (*Teacher*); SEBASTIAN F. FABELLO "; PANTALEON U. BACOMO "; SERAFIN F. VILLODRES "

SAN CARLOS R. H. S.
JULIAN R. MAMARIL (*Teacher*); ANANIAS M. ZARATAN "; APOLONIO R. MUÑOZ "; ARCADIO G. MATELA "

TRINIDAD AGR. SCH.
HOSPICIO N. VIBAR (*Teacher*); LUIS J. DANGILAN "; CALIXTO T. ZAMUCO "

BAYBAY AGR. SCH.
FELIX D. CARREON (*Teacher*); ISIDORO L. MADJUS "; PERFECTO C. BONGATO "; ANTONIO M. DURANO "

LUMBATAN AGR. SCH.
ACELO C. BADELLES (*Teacher*); BASILIO PONCE "; SIMEON C. SANTOS "

CABAGAN R. H. S.
ALFONSO CAGURANGAN (*Teacher*); ISIDORO D. GUZMAN "

GUINOBATAN R. H. S.
DELFIN DIVINAGRACIA (*Teacher*); JUAN T. NERIC "

STA. MARIA R. H. S.
CIRILO CASARENO (*Teacher*); FRANCISCO PALAD "

OTHER AGR. SCHOOLS
- CONSTANTINO DERECHO — *Teacher, Upi Agr. School*
- GENARO R. FRIGILLANA — *Teacher, Catarman Agr. School*
- FELIX M. ESGUERRA — *Kudarangan R. H. S.*
- PASCUAL M. MATULAC — *Teacher, Kabugao R. H. S.*

OTHER HIGH SCHOOLS
- CRISPULO G. BAGUI — *Teacher, Batangas H. S.*
- JOSE BARSANA — *Teacher, Batanes H. S.*
- ANGEL B. BELANDRES — *Teacher, Batangas H. S.*
- AGRIPINO CONSTANTINO — *Teacher, Rizal H. S.*
- SEGUNDO M. CRUZ — *Teacher, Rizal H. S.*
- VICENTE FLORIDA — *Teacher, Cebu H. S.*
- SERVILLANO G. GUTIERREZ — *Teacher, Capiz H. S.*
- BERNABE A. OLOFERNES — *Teacher, Cebu H. S.*
- MARCELO B. PEÑA — *Teacher, Prov. Trade Sch., Albay*
- RAYMUNDO A. SABADO — *Teacher, La Union H. S.*
- JOSE C. SADDUL — *Teacher, Isabela H. S.*
- ANTONIO M. SORIANO — *Teacher, Pangasinan Academic H. S.*
- MAGNO T. TENEBRO — *Teacher, Cebu High School.*

ELEMENTARY SCHOOLS
- ISIDORO A. ANDAYA — *Teacher, Oras Elementary, Samar*
- RODOLFO R. ASUNCION — *Teacher, Bulan Elem., Sorsogon*
- SIMEON BACOL — *Teacher, Jagna Elem., Bohol*
- PRIMO SAN JOSE — *Teacher, Midsayap Elem., Cotobato*
- PRUDENCIO LACSON — *Teacher, City Schools, Manila*
- JUAN R. MAGSINO — *Teacher, Legarda Elem., Manila*
- FRANCISCO O. MANZON — *Teacher, Pontevedra Elem., Capiz*
- PEDRO H. VIRAY — *Teacher, Mangatarem Elem., Pangasinan*

INDUSTRIAL SUPERVISORS
- LORENZO GOCO — *Acting Industrial Supervisor for Agusan*
- ANASTACIO LIMBO — *Division Industrial Supervisor for Bukidnon*
- CIPRIANO C. NACION — *Division Industrial Supervisor for Bohol*

UNIV. OF THE PHILIPPINES

COLLEGE OF AGRICULTURE

ADMINISTRATION
- BIENVENIDO M. GONZALEZ — *Dean*
- FRANCISCO M. FRONDA — *Secretary*

AGRONOMY
- NEMESIO B. MENDIOLA — *Professor and Head*
- PEDRO A. DAVID — *Asst. Professor*
- LEON G. GONZALEZ — *Asst. Professor*
- VICENTE B. ARAGON — *Instructor*
- EULALIO P. BALTAZAR — *Instructor*
- VALERIANO C. CALMA — *Instructor*
- JOSE M. CAPINPIN — *Instructor*
- VICENTE M. DAWIS — *Instructor*
- JESUS DE GUZMAN — *Assistant*
- TORIBIO MERCADO — *Assistant*
- TEOFILO NOVERO — *Assistant*
- AMBROSIO SAN PEDRO — *Assistant*
- JOSE A. SERRANO — *Assistant*
- CLEMENTE YANGO — *Assistant*

AGRICULTURAL CHEMISTRY
- FRANCISCO O. SANTOS — *Professor and Head*
- ESTEBAN G. COLLADO — *Instructor*
- FLORENCIO A. SOLIVEN — *Instructor*
- LEOPOLDO L. VILLANUEVA — *Instructor*
- GETULIO A. GUANZON — *Instructor*
- HONORATO LUMANG — *Assistant*
- RICARDO MARFORI — *Assistant*
- NAZARIO PIDLAOAN — *Assistant*
- LAURO YNALVEZ — *Assistant*

ANIMAL HUSBANDRY
- BIENVENIDO M. GONZALEZ — *Professor and Head*
- VALENTE VILLEGAS — *Assoc. Professor and Asst. Head*
- FRANCISCO M. FRONDA — *Asst. Professor*
- JOSE P. ESGUERRA — *Instructor*
- FELIX B. SARAO — *Instructor*
- ALEJO TALEON — *Instructor*
- ENGRACIO BASIO — *Assistant*

AGRICULTURAL EDUCATION
- FANCISCO M. SACAY — *Instructor and In-charge*
- PEDRO MONTELLANO — *Instructor*
- EUGENIO A. AGUDO — *Assistant*
- FRANCISCO BARROS — *Assistant*
- NICANOR M. CASTILLO — *Assistant*
- SISENANDO REANTASO — *Assistant*
- ALBINO P. VARONA — *Assistant*
- GREGORIO GOCO — *Clerk*

ENTOMOLOGY
- LEOPOLDO B. UICHANCO — *Professor and Head*
- DEOGRACIAS VILLADOLID — *Asst. Professor*
- SILVERIO M. CENDAÑA — *Instructor*
- SANTIAGO R. CAPCO — *Assistant*
- ARSENIO CORONEL — *Assistant*
- ANDRES M. MANE — *Assistant*

AGR. ENGINEERING
- ANASTACIO L. TEODORO — *Associate Prof. and Head*
- ALEJANDRO B. CATAMBAY — *Asst. Professor*
- BENEDICTO C. DE LAS ALAS — *Instructor*
- JOSE BONDOC — *Assistant*
- JESUS MAMISAO — *Assistant*

PLANT PHYSIOLOGY
- RAFAEL B. ESPINO — *Professor and Head*
- JOSE B. JULIANO — *Instructor*
- FERNANDO DE PERALTA — *Instructor*
- ROMAN P. ESTIOKO — *Assistant*
- FELICIANO PANTALEON — *Assistant*

PLANT PATHOLOGY
- GERARDO O. OCFEMIA — *Associate Prof. and Head*
- EMILIANO F. ROLDAN — *Instructor*
- MARTIN S. CELINO — *Assistant*
- VICTORIA M. ELA — *Assistant*

RURAL ECONOMICS
- PABLO N. MABBUN — *Instructor*
- MARCELO V. ARNALDO — *Assistant*

SOILS
- INOCENCIO ELAYDA — *Professor*
- DIONISIO I. AQUINO — *Instructor*

OTHER COLLEGES

- LEOPOLDO CLEMENTE — *Associate Prof. and Head, Dept. of Zool., Coll. of Liberal Arts.*
- FRANCISCO QUISUMBING — *Associate Prof. of Chem., Coll. of Liberal Arts.*
- RAMON P. TOLENTINO — *Asst. Physical Director, U. P.*
- ANTONIO P. RACELIS — *Associate Professor, School of Forestry, U. P.*
- MOISES M. KALAW — *Instructor in Botany, Northern Luzon Jr. College*

OTHER BRANCHES OF THE GOVT.

BUREAU OF PUB. WORKS
- VENANCIO R. GARCIA — *Managing Planting Fruit Trees on Provincial Roads of Sorsogon*

PHILIPPINE NATIONAL BANK
- GREGORIO D. CASEÑAS — *Inspector, Philippine National Bank, Iloilo, Iloilo*
- TOMAS D. HARDER — *Inspector, Philippine National Bank, Bacolod, Occidental Negros*
- MARCIANO A. REYES — *Agricultural Inspector, Philippine National Bank*

BUREAU OF INTERNAL REVENUE
- SANTIAGO FESTIN — *Supervising Tobacco Inspector, Secretary, Tobacco Board, Manila*
- ARTEMIO GESMUNDO — *Tobacco Inspector, Dagupan, Pangasinan*
- GAUDENCIO A. VENTURA — *Tobacco Inspector, Manila*

BUREAU OF CONSTABULARY
- JOSE P. ESGUERRA — *Special Agent, Bureau of Constabulary*

BUREAU OF NON-CHRISTIAN TRIBES
- BIENVENIDO M. GONZALEZ — *Special Agent, Bureau of Non-Christian Tribes*
- TEOFILO G. CALINGASAN — *Deputy Governor-at-large, Malaybalay, Bukidnon*
- CENON R. PAULICAN — *Deputy Governor of Bukidnon*
- CLARO SAMONTE — *Superintendent of Non-Christians for Rizal Province*

BU. OF FORESTRY
- ILDEFONSO PALISOC — *Forest Guard, Agricultural College, Laguna*

BUREAU OF ANIMAL INDUSTRY
- EXEQUIEL ALCASID — *Superintendent, Alabang Stock Farm*
- GERONIMO MIÑANO — *Asst. Animal Husbandman, Alabang Stock Farm*
- FELIX ALCARAZ — *Asst. Animal Husbandman, Alabang Stock Farm*
- JORGE MENDOZA — *Helper, Batangas Horse Breeding Station*

PROV. GOVT.
- JUSTINO GUIYAB — *Prov. Poultry Supervisor of Cagayan*

MPL. GOVT.
- LEONCIO M. LIMPIADO — *Municipal President of Naval, Leyte*

U. S. ARMY
- NEMESIO CATALAN — *First Lieut., Camp Stotsenburg, Pampanga*

FISH AND GAME ADM.
- CANUTO G. MANUEL — *Fish and Game Administration (Ornithologist)*
- DEOGRACIAS VILLADOLID — *Deputy Game Warden*

FOREIGN SERVICES

SIAM
- IANG CHANDRASTITYA — *Teacher in Agri., Kings College*
- GEORGE KHOMSON — *Teacher in Agriculture*
- ROEM PURNARIKSHA — *Instructor in Science, Chulalonghorn University*
- THONGDEE RESANONT — *Headmaster, Agric. Teachers Training School*
- CHAROON SUEBSAENG — *Soil Technologist, Dept of Agriculture*
- CHARAS SUNDARASINHA — *Asst. to Principal, Agric. Teachers Training School*
- SWASDI VIRADEJA — *Instructor, Agri. Teachers Training School*

BRITISH NORTH BORNEO
- FELIX S. TELADO — *Senior Agricultural Asst., Agr. Dept.*
- FELICIANO M. CALACALA — *Junior Agr. Asst., Dept. of Agriculture*

UNITED STATES
- GUY CLINTON — *Teacher in High School, Central High School, Wash. D. C.*
- JOSEPH COCANNAUER — *Teacher in High School, Stillwater, Oklahoma*

SUMATRA
- BASUNIE SAROPIE — *Agronomist, Palembang*

INDIA
- EUFEMIANO DE B. PEREIRA — *Agric. Expert and Chief of the Second Agric. Division*

JAVA
- PEE TEK HAP — *Chemist, Govt. Sugar Central, Tanguerang*

BUREAU OF PRISONS

IWAHIG PENAL COLONY
- PEDRO S. PAJE — *Second Asst. Supt. and Chief, Farming and Poultry Activities*
- CANDIDO BAGAOISAN — *Chief, Industrial and Farming Division*
- PASCUAL ROBIN — *Chief, Horticulture Division*
- HERMINIO ESPINO — *Chief, Agronomy Division*
- PASCUAL N. ANDRES — *Chief, Animal Husbandry Division*
- CLAUDIO ARELLANO — *Chief, Inagawan Division*

DAVAO PENAL COLONY
- FRANCISCO B. SANTOS — *Asst. Superintendent*
- SEVERINO SALVADO — *Chief, Poultry Farm*
- DANIEL F. ASUNCION — *Farming Instructor*

CORRECTIONAL INSTITUTION FOR WOMEN
- VALENTIN G. AMON — *Chief, Bureau of Prisons Poultry Farm*
- PATERNO V. BAYAN — *Asst., Poultry Farm and Hog Raising Industry*

SAN RAMON PENAL COLONY
- SEVERO G. YAP — *Asst. Superintendent*

BILIBID PRISON
- MELECIO M. MANIO — *Kitchen and Bakery Foreman*

SILVER ANNIVERSARY

SUPPLEMENT I

to the

COLLEGE OF AGRICULTURE BIWEEKLY BULLETIN

AND

THE PHILIPPINE AGRICULTURIST

1934

THE COLLEGE OF AGRICULTURE
UNIVERSITY OF THE PHILIPPINES

The College of Agriculture at Los Baños is the only agricultural institution of University grade in the Philippines. It is also the only fully developed University college in the tropics of the world devoted to agriculture and the agricultural sciences.

Its avowed object is to teach Philippine agriculture, and to properly accomplish this task it must build up and constantly collect a mass of local agricultural knowledge. The methods of science are admittedly the best and most successfully used in the solution of human problems. The College therefore trains its students for effective work in the agricultural sciences so that in whatever capacity they may find themselves in later life they can face their problems intelligently and master them through orderly procedure.

The College is now completing its quarter century of existence. The graph presented herein illustrates the position the institution has carved for itself in the direction of the governmental agricultural development program of the country. The two most important agencies for the stimulation of the agriculture of the country, the College itself and the Bureau of Plant Industry, are now almost completely manned by graduates of the institution. These services were at one time absolutely under the direction of imported personnel. Other government agencies engaged incidentally in agricultural activities have entrusted the direction of such activities to the graduates of the College as well as the training of technical personnel for their agricultural promotional programs.

This is merely one aspect of the work of the College of Agriculture.

There has, therefore, been ample justification for keeping this College the effectively going concern that it is through adequate support. We are confident that the recognition of the vital function of this Unit in the economic life of the country will continue to find expression in unabating if not increasing subsidy, despite the present economy that the government has had to effect in many of its branches.

Contribution of the College of Agriculture to the Promotion of Private Agricultural and Other Enterprises

COLLEGE OF AGRICULTURE ALUMNI

IN BUSINESS or PROFESSIONS

BUSINESSMEN

- SEVERINO S. AQUINO — *General Merchant, San Carlos, Pangasinan*
- LORENZO JOAQUIN — *Merchant, Santa Ana, Manila*
- ENRIQUE LOPEZ — *Merchant, Manila*
- PAULINO C. MENOR — *Employed in a private firm, Davao, Davao*
- GERMAN M. PULGAR — *Businessman, Lingayen, Pangasinan*
- RAMON O. R. REYES — *Private Worker, Santa Cruz, Laguna*
- CONRADO T. REYES — *Businessman, Malolos, Bulacan*

PROFESSIONALS

- ANTONIO CHANCO — *Dentist, American Red Cross, Philippine Chapter, Manila*
- ERNEDO T. LASERNA — *Physician, Santa Rosa, Laguna*
- JOSE P. TIRONA — *Resident Physician, U. P. Infirmary, Manila*
- JOSE M. TRINIDAD — *Attorney, Manila Gas Corp., Manila*

IN LIVE STOCK FARMING

POULTRY

- ANANIAS T. CRISOSTOMO — *Poultry Farmer, Malolos, Bulacan*
- JOSE O. CRUZ — *Poultryman, Angeles, Pampanga*
- FELIX S. GAMO — *Manager, Elvi Poultry Farm, San Nicolas, Manila*
- PERPETUO GAVARRA — *Manager, Ralla Poultry Farm, Tabaco, Albay*
- RAMON T. MERCADO — *Poultryman, Batangas, Batangas*
- FERNANDO C. ORDOVEZA — *Poultry Raiser and Veterinarian, Bay, Laguna*
- JUAN S. PADILLA — *Poultryman, Villa Carmenchu, Baguio, Mt. Province*
- DOMINADOR D. PASCUAL — *Poultry Farmer, La Paz, Tarlac*
- TELESFORO TIOAQUEN — *Poultryman, Mexico, Pampanga*
- HILARIO M. TURGANO — *Poultryman, Washington, U. S. A.*
- MANUEL TUYA — *Manager, Poblador Poultry Development, Ipo, Norzagaray, Bulacan*

DUCKS

- GAUDENCIO B. CRUZ — *Duck Raiser and Fisherman, Pila, Laguna*

HOGS

- GABRIEL B. GONZALES — *Hog Raiser, Paombong, Bulacan*

HORSES

- JOSE NOGUERRA — *Horse Breeder, Batangas, Batangas*

CATTLE

- TEODORO N. PEPITO — *Asst. Manager, Mercedes Ranch, Malaybalay, Bukidnon*
- AMBROSIO ABESAMIS — *Live-stock Raiser, Bayombong, Nueva Vizcaya*
- FLORENTINO F. CRUZ — *Rancher, Pioneer Stock Farm, Jagcal, Valencia, Malaybalay, Bukidnon*

FARM MANAGERS

MANAGERS AND ADMINISTRATORS OF HACIENDAS AND FAMILY FARMS

- EMILIO M. AFRICA — *Administrator, Lutucan, Tayabas*
- SALVADOR J. ASCALON — *Administrator, Hda. Buenos Aires, Victorias, Occ. Negros*
- SANTIAGO BABAO — *Manager of Estate Laiya, Bolbok, Batangas*
- AMADO N. BALAGTAS — *Manager, Sugar Cane Plantation, Bogo, Cebu*
- ARTURO BENGZON — *Administrator of Heirs of Vicente Bengzon, Camiling, Tarlac*
- PORFIRIO CARANDANG — *Manager, Hda. Guerrero, Catabañgan, Camarines Sur*
- FELIX D. ENRILE — *Farmer, Hda. D. M. Enrile, Muñoz, Nueva Ecija*
- PEDRO P. ERCE — *Farm Manager, Hda. Carmelita, San Francisco del Monte, Bulacan*
- JUAN D. ESTAÑOL — *Superintendent, Hda. Oliva, Murcia, Occ. Negros*
- ALBERTO A. ESTRADA — *Superintendent, Hda. San Jose, San Jose, Mindoro*
- FERMIN J. GAMBOA — *Manager, Sugar Cane Plantation, Hacienda de Vicente Lopez, Vallehermoso, Or. Negros*
- JUANITO GARRIDO — *Administrator of Family Farm, Cabatuan, Iloilo*
- VICENTE D. GAVIOLA — *Farm Manager, Asesoria, Maliualu, Bacolor, Pampanga*
- DIODATI R. GOCHANGCO — *Manager and Partner, Novaliches Farm House, Caloocan, Rizal*
- FLORENCIO Y. GOPEZ — *Manager, Hacienda Masulib, Bamban, Tarlac*
- NICOLAS D. GRECIA — *Gen. Manager, Hda. Maria Luisa, Victorias, Occ. Negros*
- JOSE P. GUIA — *Manager of Private Farm, San Pablo, Laguna*
- NEWTON L. JISON — *Manager, Sugar Cane Plantation, Bacolod, Occ. Negros*
- BENJAMIN LAZATIN — *Manager, Hacienda Lazatin, Angeles, Pampanga*
- GREGORIO B. LONTOK — *Technical Adviser, Hacienda Ynchausti & Co., Sara-Ajuy, Iloilo*
- DEOGRACIAS MALABANAN — *Foreman, Los Baños, Laguna*
- IRINEO N. MALIGAYA — *Administrator, Hda. Carminia, Escalante, Occ. Negros*
- GAUDENCIO G. MEJIA — *Farm Manager, Murcia, Tarlac*
- EUFRAIN MORALES — *Hda. Administrator and Manager, Moncada, Tarlac*
- SIMPLICIO OLIVEROS — *Manager, Candaba Estate, Baliwag, Bulacan*
- LORENZO PADERNA — *Hda. Ledesma, La Carlota, Occ. Negros*
- JOSE G. PADILLA — *Hacienda Santa Maria, Talisay, Occ. Negros*
- ANTONIO L. PEDROSO — *Manager, Bar Plantation, Balingasag, Or. Misamis*
- MARIANO PAMINTUAN — *Manager of Family Farm, Angeles, Pampanga*
- DANIEL B. PEÑA — *Farm Manager, Tabaco, Albay*
- DIONISIO C. POLO — *Farm Manager, Baybay, Leyte*
- GREGORIO F. QUIAOIT — *Farm Manager, Hda. Ongsiako, Nampicuan, Nueva Ecija*
- COSME REYNES — *Farm Manager, Cebu*
- JOSE A. SAGUIN — *In charge of Dapitan Plantation, Peñan, Dipolog, Zamboanga*
- ANTONIO C. SANCHEZ — *Manager, Hacienda Sto. Rosario, Binalbagan, Occ. Negros*
- LUIS SOL DE VILLA — *Manager, Hacienda Paraiso and Columbia, Fabrica, Occ. Negros*
- FELIX S. SORIANO — *Manager, Hacienda Bayabas, Fabrica, Occ. Negros*
- JORGE TINGZON — *Farm Manager, Sariaya, Tayabas*
- ELADIO J. TORRES — *Manager and Farm Proprietor, Pili, Camarines Sur*
- CELSO S. TUASON — *Manager, Hda. Mariquina, Mariquina, Rizal*
- DOMINGO P. TUGADE — *Manager of Family Farm, Naguilian, Isabela*
- FELIX F. VILLA — *Manager and Agriculturist, Hacienda de Sra. Maria Jison, Balayan, Batangas*

IN GENERAL FARMING

AGUSAN
- PEDRO S. ROJALES — *Farmer and Lumber Dealer, Nasipit, Agusan*

ALBAY
- JUAN G. LIZASO — *Farmer, Baras, Catanduanes, Albay*

BATAAN
- GAUDENCIO CONSUNJI — *Farmer, Orani, Bataan*

BATANGAS
- URBANO A. MOJARES — *Farmer and Baker, Lipa, Batangas*
- NICOLAS L. GONZALES — *Farmer, Tanauan, Batangas*

BOHOL
- GERMAN YAP — *Farmer, Jagna, Bohol*
- ARSENIO A. GOCO — *Farmer, Colonia, Carmen, Bohol*

BUKIDNON
- ERNESTO E. ELAZEGUI — *Farmer, Sta. Fe, Bukidnon*
- NUMERIANO FLORITA — *Farmer, Malitbog, Bukidnon*
- DOMINGO LIMBO — *Farmer, Maramag, Bukidnon*

BULACAN
- JOSE A. MARIANO — *Farmer, Bigaa, Bulacan*
- EMILIO T. DAVID — *Farmer, San Miguel, Bulacan*

CAGAYAN
- RAMON G. TOMANENG — *Agriculturist and Veterinarian, Apan, Cagayan*
- SEVERINO IMATONG — *Farmer, Piat, Cagayan*

CAM. SUR
- VICENTE F. HIDALGO — *Farmer, Naga, Camarines Sur*
- LEOPOLDO G. MENDOZA — *Farmer, Sagnay, Camarines Sur*

CAPIZ
- TITO YOTOKO — *Farmer, Capiz, Capiz*
- ROBERTO H. TIROL — *Farmer and Livestock Raiser, Ibajay, Capiz*
- VALERIANO S. ONG — *Homesteader, Ibajay, Capiz*
- BASILIO Y. ILEDAN — *Farmer, Malinao, Capiz*
- BALTAZAR A. CORCINO — *Farmer, Mambusao, Capiz*

CAVITE
- MELQUIADES S. PUGEDA — *Farmer, Rosario, Cavite*
- BENEDICTO C. LEAÑO — *Farmer, General Trias, Cavite*

COTABATO
- CRISPIN B. VILLANUEVA — *Farmer, Parang, Cotabato*
- VICTOR F. BURGOS — *Farmer, Parang, Cotabato*
- ANICETO PADILLA — *Homesteader, Cotabato*

DAVAO
- JOAQUIN Z. MAYPA — *Farmer, Padada, Sta. Cruz, Davao*
- SANTIAGO P. LAGOC — *Farmer, Bago, Davao*

ILOILO
- HONORIO R. SAMONTE — *Farmer, Estancia, Iloilo*
- ISABELO SONZA — *Farmer, Lucena, Sta. Barbara, Iloilo*
- AMADO A. ANDRADA — *Farmer, Carles, Iloilo*
- PLACIDO L. CAVILLERO — *Farmer, Cabudian, Dueñas, Iloilo*
- POLICARPO PADLAN — *Farmer, Iloilo, Iloilo*

ISABELA
- TOMAS FERRER — *Farmer and Merchant, Echague, Isabela*

LAGUNA
- MAMERTO E. LIMUACO — *Farmer, Pagsanjan, Laguna*
- FIDEL H. ALONTE — *Homesteader and Druggist, Los Baños, Laguna*
- EMILIO AQUINO — *Farmer and Business Man, Pagsanjan, Laguna*

LA UNION
- TEOFILO A. NISCE — *Farmer and General Merchant, Luna, La Union*

MANILA
- JOAQUIN J. GONZALEZ — *Farmer and Jewelry Merchant, Manila*

MARINDUQUE
- DIONISIO P. PASTORFIDE — *Farmer, Sta. Cruz, Marinduque*

ORIENTAL MISAMIS
- JOSE P. CORRALES — *Farmer, Mambajao, Or. Misamis*
- VIRGILIO PINEDA — *Farmer, Cagayan, Or. Misamis*

MT. PROV.
- LEON B. EDROZO — *Farmer, Luna, Apayao, Mt. Prov.*

NUEVA ECIJA
- SEBASTIAN SALVA CRUZ — *Farmer, Cabanatuan, Nueva Ecija*
- PACIFICO L. MASIBAY — *Farmer, Zaragoza, Nueva Ecija*
- PABLO S. GARCIA — *Farmer, Cabanatuan, Nueva Ecija*
- JOSE C. GARCIA — *Farmer, Quezon, Nueva Ecija*
- GREGORIO M. FRANCISCO — *Farmer, Sta. Rosa, Nueva Ecija*
- JUAN D. ESGUERRA — *Farmer, Licab, Nueva Ecija*

NUEVA VIZCAYA
- FELICISIMO D. SURATOS — *Farmer and Homesteader, Limbo, Diadi, Bagabag, Nueva Vizcaya*
- ANDRES L. PACIS — *Farmer, Bagabag, Nueva Vizcaya*
- ANTONIO REYES — *Farmer, Nueva Vizcaya*

ORIENTAL NEGROS
- ANICETO VILLAMIL — *Farmer, Dumaguete, Or. Negros*
- SIMEON S. FLORES — *Farmer, Dao, Dumaguete, Or. Negros*

PALAWAN
- VALENTIN MACASAET — *Farmer and Homesteader, Puerto Princesa, Palawan*

PAMPANGA
- FRANCISCO J. VALDEZ — *Farmer, Angeles, Pampanga*
- SIMPLICIO TIGLAO — *Farmer, Mabalacat, Pampanga*
- ANDRES P. GOSECO — *Farmer, Guagua, Pampanga*

PANGASINAN
- MARIANO F. SORIANO — *Farmer, Manaoag, Pangasinan*
- ANTONIO C. PEREZ — *Farmer, Alaminos, Pangasinan*
- MARCELINO B. GARCIA — *Farmer, Vega, S. Carlos, Pangasinan*
- EPIFANIO ENERGA — *Farmer, Alaminos, Pangasinan*

RIZAL
- PANTALEON BAUTISTA — *Farmer, Malabon, Rizal*
- ALFREDO A. FRANCISCO — *Farmer, Muntinlupa, Rizal*

SORSOGON
- FELICIANO R. REVECHE — *Farmer, Sorsogon, Sorsogon*

TARLAC
- ENRIQUE M. SIBAL — *Farmer, Bamban, Tarlac*
- NICANOR BARTOLOME — *Farmer, Gerona, Tarlac*
- MOISES P. CASTRO — *Farmer, Concepcion, Tarlac*
- VICTOR T. FELICIANO — *Farmer, Concepcion, Tarlac*
- ESTANISLAO T. MARAÑON — *Farmer, Victoria, Tarlac*
- EULOGIO RODRIGUEZ — *Farmer and Businessman, San Manuel, Tarlac*

TAYABAS
- FRANCISCO P. LAGO — *Farmer and Buntal Dealer, Piris, Guinayañgan, Tayabas*
- FRANCISCO A. ABADILLA — *Farmer, Catanauan, Tayabas*

ZAMBALES
- PETRONILO P. ANTIPOLO — *Farmer, San Antonio, Zambales*
- MAXIMO P. CANONIZADO — *Farmer, San Antonio, Zambales*

- JOSE F. ZAMORA — *Farmer and Regent, University of the Philippines*

IN SUGAR CENTRALS

BACOLOD-MURCIA MILLING CO.
- BASILIO D. DESEMBRANA — *Agronomist*

BATAAN SUGAR CO.
- GERARDO G. CAPATI — *Chemist*
- CIRIACO B. SERRANO — *Chief Chemist*

BINALBAGAN SUGAR ESTATE
- SEGUNDO D. LABAYEN — *Superintendent of Fabrication*
- FERNANDO M. FERNANDEZ — *Assistant Chemist*
- JULIO JAMIAS — *Agronomist*
- DIOSCORO V. RETIRO — *Technical Field Assistant*

CALAMBA SUGAR ESTATE
- TRINIDAD VILLAS — *Chemist*
- ENRIQUE D. HEMEDES — *Assistant Chemist*
- ATANACIO T. CARANDANG — *Head, Research Department*
- MARTIN G. CALIÑGASAN — *Agronomist*
- SILVIO A. DECENA — *Field Inspector*
- JOSE T. ALHAMA — *Assistant Field Inspector*
- ARTEMIO L. RILLO — *Field Assistant*
- EDUARDO A. MENDOZA — *Experimental Assistant*

CEBU SUGAR CO.
- JOSE H. CAMPO — *Agronomist*
- CONRADO S. VELOSO — *Assistant Chemist*

CENTRAL AZU. BAIZ
- GIL O. OPIANA — *Assistant Chemist*

CENTRAL AZUCARERA DON PEDRO
- HERMENEGILDO R. ROSALES — *Chief Chemist*
- ARTEMIO P. MALABAYABAS — *Sugar Cane Field Inspector*
- ARTURO DE LOS REYES — *Sugar Cane Field Inspector*

CENTRAL LEONOR
- CORNELIO G. LEMONCITO — *Chemist and Supt. of Boiling House*

CENTRAL SANTOS-LOPEZ
- AGUSTIN L. HERMANO — *Sugar Chemist*
- FRANCISCO S. GOMEZ — *Assistant Chemist*

HAWAIIAN-PHIL. CO.
- AMADO J. DE LA CRUZ — *Assistant Chemist*

HIND SUGAR CO.
- JOSE P. STO. DOMINGO — *Chemist*

ISABELA SUGAR CO.
- CATALINO G. AURELIO — *Chief Chemist*
- EGMIDIO D. EBREO — *Assistant Chemist*
- PEDRO VALENZUELA Y DELGADO — *Assistant Chemist*

CENTRAL AZUCARERA DE LA CARLOTA
- ALEXANDER GORDON — *Chief, Ag. and Expt. Dept.*
- JULIAN R. GOMERI — *Asst. Supt. of Boiling House*
- LORETO V. VALERA — *Assistant Chemist*
- SALVADOR C. ALDABA — *Analyst*
- GENARO S. LAYUG — *Chemist*
- DOMINGO S. REGNER — *Asst. Chemist and Asst. Supt. of Fabrication*

LOPEZ SUGAR MILL COMPANY
- ANGEL H. SEVERINO — *Chemist*
- FRANCISCO L. GESTOSO — *Agronomist*
- DOMINADOR H. TAN — *Chemist*

MAAO SUGAR CENTRAL
- AGUSTIN RUIZ DE LUZURIAGA — *Chief Chemist*
- BALDOMERO G. SALINAS — *Ag. and Research Assistant*

MALABON SUGAR REFINING CO.
- RAMON K. HABALUYAS — *Asst. Supt. and Head Dept. of Fabrication*
- EUSEBIO A. BATACLAN — *Assistant Supt. of Fabrication*
- RAMON A. CRUZ — *Chemist*

NORTH NEGROS SUGAR CO.
- FRANCISCO M. SEVILLENO — *Assistant Soils Chemist*
- JOSE C. GATON — *Assistant Soils Chemist*

MABALACAT SUGAR
- FEDERICO G. ISAAC — *Chief Chemist*

NUEVA ECIJA SUGAR MILLS
- LEOPOLDO P. ABES — *Agronomist*
- GELACIO P. ABES — *Assistant Chemist*

PAMPANGA SUGAR MILLS
- ENRICO B. GAMO — *Assistant Supt., Expt. Station*
- JUAN D. ATIENZA — *In Charge in Laying out Expts.*

PAMPANGA SUGAR DEVELOPMENT CO.
- DELFIN SUERTE — *Chief Chemist*
- TRANQUILINO D. VENTURA — *Chemist and Supt. of Fabrication*
- MARCELINO L. SASON — *Assistant Chemist*
- ALEJANDRO C. GUIANG — *Agriculturist*

PANIQUI SUGAR MILLS
- RAFAEL B. ROTOR — *Chief Chemist*
- MANUEL R. MONSALUD — *Assistant Chemist*

PHIL. MILLING CO.
- DAMASO O. ROQUE — *Division Overseer*
- LEONARDO SALINAS — *Division Overseer*

PHIL. SUGAR DEVELOPMENT
- ANDRES L. RIVERA — *Chemist and Agronomist*

PILAR SUGAR CENTRAL
- ANTONIO V. GUANZON — *Agronomist*
- FELIX R. AMPARADO — *Technical Asst. Ag. and Expt. Dept.*

CENTRAL SARA-AJUY
- PEDRO G. JACOMINA — *Agronomist*

SAN ISIDRO SUGAR
- WENCESLAO TINGZON — *Chemist*

TALISAY MILLING
- JUAN P. PEGIÑA — *Technical Assistant*

CENTRAL AZU. TARLAC
- ELEAZAR T. SITCHON — *Assistant Chemist*

VICTORIAS MILLING CO.
- JOSE C. MIRAFLORES — *Supt. of Boiling House*
- PEDRO P. PORQUEZ — *Agriculturist, Expt. Dept.*
- EDILBERTO S. PUNZALAN — *Sugar Cane Field Inspector*

SUGAR PLANTERS AND PLANTERS' ASSOCIATIONS

PLANTERS' ASSOCIATIONS

- GENARO C. BERMEJO — *Chief Chemist, Sugar Planters' Assn., Inc., Barotac, Nuevo, Iloilo*
- PRIMO R. CARREON — *Chemist, Asociación Agricola de la Región Oeste de Batangas, Central Don Pedro, Nasugbu, Batangas*
- FRANCISCO V. DEOMANO — *Assistant Chemist, Planters' Association, Pampanga Sugar Mills, Del Carmen, Pampanga*
- EMILIO Z. ESMERALDA — *Chemist, Asociación de Agricultores de La Carlota, La Carlota Sugar Central, Occ. Negros*
- ATANACIO HIZON — *Chemist, Pasudeco Planters' Association, San Fernando, Pampanga*
- BENJAMIN L. HOLLERO — *Chief Chemist and Manager, Assoc. de Agric. de Binalbagan Est., Binalbagan Estate, Inc., Occ. Negros*
- MANUEL L. HOLLERO — *Asst. Chemist, Planters' Assn., Isabela, Sugar Co., Inc., Isabela, Occ. Negros*
- ERNESTO B. JAMORA — *Chemist, Sagay Planters' Assn., Lopez Sugar Mill Co., Inc., Fabrica, Occ. Negros*
- SEVERO MARIANO — *Planters' Chemist, Calumpit, Bulacan*
- JOSE J. MIRASOL — *Chemist, Planters' Association, North Negros Sugar Co., Inc., Manapla, Occidental Negros*
- ERNESTO R. MONTINOLA — *Chemist, Isabela Sugar Planters' Assoc., Isabela Sugar Co., Inc., Isabela, Occ. Negros*
- QUIRINO D. RENDON — *Chemist, Pilar Planters' Assoc., Pilar Sugar Central, Pilar, Capiz*
- JOSE A. RIVERA — *Planters' Chemist, Mt. Arayat Sugar Co. and Planter of same, Arayat, Pampanga*
- GONZALO H. SALAZAR — *Chemist and Secretary-Treasurer, San Carlos Planters' Assoc., San Carlos, Occ. Negros*
- IRINEO J. SEVILLA — *Chemist, Sugar Planters' Assoc., Central Sara-Ajuy, Iloilo*
- FELIPE M. VILLA — *Assistant Chemist, Isabela Planters' Assoc., Isabela Sugar Co., Inc., Isabela, Occ. Negros*
- MANUEL VILLANO — *Chemist and Cane Technologist, Central Azucarera Don Pedro, Nasugbu, Batangas*

PHILIPPINE SUGAR ASSOCIATION

- SILVESTRE ASUNCION — *Technical Assistant, P. S. A., Central Azucarera Don Pedro, Nasugbu, Batangas*
- ROBERTO C. BETIA — *Assistant Chemist, P. S. A., Pulupandan Central, Pulupandan, Occ. Negros*
- ALFONSO Q. BRIONES — *Assistant Cane Breeder, P. S. A., Manila*
- ELIAS C. EUBANAS — *Assistant Chemist, P. S. A., Bureau of Science, Manila*
- FEDERICO P. GOSECO — *Entomologist, P. S. A., Canlubang, Laguna*
- ANTONIO R. DE LUZURIAGA — *Plant Physiologist, P. S. A., Manila*
- MONICO A. NECESITO — *Technical Assistant, P. S. A., Ormoc Sugar Co., Leyte*
- SERGIO M. TORRES — *Assistant Chemist, P. S. A., Bureau of Science, Manila*
- GETULIO VIADO — *Assistant Entomologist, Philippine Sugar Assn., Manila*

SUGAR CANE PLANTERS

- MARCELO CRISOSTOMO — *Planter, La Castellana Sugar Cane Plantation, Occ. Negros*
- TEODORICO C. GHOFULPO — *Sugar Cane Planter, Binalbagan Estate Planters' Assn., Binalbagan, Occ. Negros*
- VENERANDO P. MARILAO — *Planter, Rosario Plantation, Maao Central, Maao, Occ. Negros*
- MARIANO G. MEDALLA — *Hacendero, Bacolod, Occ. Negros*
- MELQUIADES L. MEDINA — *Planter, Hacienda Estela, La Carlota, Occ. Negros*
- FRANCISCO M. MENDOZA — *Sugar Cane Planter, La Carlota, Occ. Negros*
- ELIAS H. PAÑGANIBAN — *Sugar Planter, Faraon, Fabrica, Occ. Negros*
- ELIAS V. SOMBITO — *Hacendero and Businessman, Pontevedra, Occ. Negros*
- EUSEBIO TERUEL — *Planter, Hacienda Victoria, Magallon, Isabela, Occ. Negros*
- EDMUNDO G. YASAY — *Planter, Maao Sugar Central Co., Bago, Occ. Negros*

IN PRIVATE EDUCATIONAL INSTITUTIONS

ADMINISTRATORS

- TEOFILO P. ALLAS — *Director, Pangasinan Eastern Academy, Tayug, Pangasinan*
- DOMINADOR CLEMENTE — *Principal, Maquiling School, Agricultural College, Laguna*
- SIXTO A. GAERLAN — *Teacher, St. Louis School, Baguio, Benguet, Mt. Prov.*
- EVARISTO GOTERA — *Director, San Nicolas Academy Guimbal, Iloilo*

TEACHERS

- QUIRICO ABRAJANO — *Teacher, Zambales Academy, San Narciso, Zambales*
- GREGORIO R. BRIONES — *Teacher, Laguna Academy, San Pablo, Laguna*
- PEDRO MALABANAN — *Teacher, Mabini Academy, Lipa, Batangas*
- ANACLETO R. PELIÑO — *Professor of Botany, Letran College, Manila*
- JUAN R. PRONTO — *Instructor, Central Philippine College, Jaro, Iloilo*
- CATALINO RAYO — *Teacher, Dagupan Institute, Dagupan, Pangasinan*
- FIDEL REYES — *Teacher, Tayabas Western Academy, Candelaria, Tayabas*

IN OTHER INDUSTRIES

MANILA

- DIONISIO CALVO — *Assistant Manager, Manila Sporting Goods*
- ISIDORO R. COLLADO — *Life Insurance Agent*
- JOSE Q. DACANAY — *Stockman and Farmer Journal, Manila*
- JACINTO B. LEONCIO — *Agent, Insular Drug Co.*
- RAMON ORDOVEZA — *In charge, Printing Department, Carmelo and Bauermann, Inc.*
- MIGUEL A. ORTIZ — *Manufacturer of Ice Drops and Candy Factory*
- NICASIO A. TUASON — *General Manager, The Eastern Theatrical Enterprises, Inc.*
- BLAS C. VELEZ — *Cashier, Manila Gas Corporation*

[illegible]

- JUAN G. TUCAY — *Analytical Department, Goldfield Mining Co., Baguio*

CEBU

- MARTIN LEONCIO — *Assistant Chemist, Cebu Portland Cement Co., Naga, Cebu*

ZAMBOANGA

- ANGEL AFRICA — *Chemist, Philippine Cutch Corp.*
- MIGUEL G. CASTRO — *Assistant Chemist, Philippine Cutch Corporation, Zamboanga, Zamboanga*

SILVER ANNIVERSARY

SUPPLEMENT II

to the

COLLEGE OF AGRICULTURE
BIWEEKLY BULLETIN

AND

THE PHILIPPINE AGRICULTURIST
1934

THE COLLEGE OF AGRICULTURE
UNIVERSITY OF THE PHILIPPINES

In the early days of the College the largest demand for its graduates was by the government for technical service. How the College met this demand is shown in Supplement I.

In later years the demand shifted from government to private enterprises. This graph indicates the occupations of graduates working with private agricultural industries and in private agricultural undertakings. Most conspicuous is their participation in the sugar and the live stock industries. Roughly eighty per cent of the technical personnel of Philippine sugar centrals and the Philippine Sugar Association are alumni of the College. These positions were formerly occupied by foreigners with technical training. Each year more and more graduates of the College are being employed as managers of large private haciendas, but the great majority manage smaller family holdings.

The usual plan among graduates with no capital and whose families have little or none is to work on a salary for a time and through saving accumulate money which they invest in farm land or live stock. When the enterprise has grown sufficiently to require their personal attention, they resign from their position and devote their full time to their private undertakings.

The industrialization of basically agricultural countries like Germany and Japan has been accomplished in large measure by the ready availability of well trained technicians. The College of Agriculture has been and is largely instrumental in the production of technical personnel for the industrialization of agricultural products in the Philippines.

This is one contribution of the College of Agriculture to the material development of the Philippine Islands.

OUR COLLEGE THESES—A STIMULUS TO ACCOMPLISHMENT [1]

Last year, while the writer was at the College of Agriculture and Forestry, University of Nanking, China, he found those responsible for the curriculum particularly interested in the thesis requirements and regulations which have gradually been developed in our College of Agriculture. It was something of a surprise to realize that what to our faculty and students is the usual routine of coöperative student-faculty effort in carrying out and writing up a piece of original research was an entirely new idea to the faculty there. This started the writer thinking of the question of students' research in the numerous agricultural colleges he had had the privilege of visiting in India, Japan and China during his seventeen years of work in agricultural research and instruction in the Orient. He could recall no other institution which had any such elaborate or effective arrangement as ours: an arrangement that has certainly demonstrated its effectiveness through the publication during the first quarter century of the life of the College, just closed, of over four hundred and fifty papers recording the original research of bachelors' theses. Therefore the nature of the thesis as prepared and presented in this College, together with some of the details of its approval and publication, or of keeping the material on record, are presented here in the belief that some similar system could very profitably be gradually developed for other agricultural colleges, particularly those situated in pioneer regions, where it is imperative not only to obtain as large a mass as possible of useful data, but also to maintain a stimulus to keep the faculty actively engaged in research.

In order to enable our College to adequately instruct our students and equip them to meet the agricultural problems of these Islands, our outstanding and continuous need is a body of reliable information regarding the agriculture of the country and its basic sciences. In recent years there have been other agencies, both official and private, which have gathered valuable data upon which to base progress in agriculture, but in the earlier years before many of our

---

[1] General contribution from the College of Agriculture No. 435.

students had graduated and were thus prepared to make up the major portion of the staffs of other scientific institutions in these Islands, there was no organization in the Archipelago which was adequately meeting the needs for essential basic information. Indeed, though notable progress had been made in tropical agriculture in other parts of the world, there was still too little knowledge of the comparative conditions between the Philippines and the other countries, so that it was not at all safe to assume that the findings in those regions would apply to the Philippines. Not even today, and much less so when this college was founded, is there adequate knowledge of the agricultural factors and conditions prevailing in the various parts of the Philippines; this deficiency is particularly unfortunate in the less well known and developed portions of the Islands, where agricultural pioneering has so many and such serious problems to meet.

Just as in the early days on this Campus, faculty and students had to work together to clear away the *parang* jungle, in order to have fields for cultivation of the experimental cultures, so it has been imperative for the faculty and students to work together to develop our own foundation material for instruction and for a basis for more thorough research upon the local agricultural problems. Dr. E. B. Copeland, the active and able founder of this College, with the first class instituted the senior thesis as a requirement for graduation, the thesis to be an original study upon some practical problem of agriculture or of one of the related sciences. Thus very early in the life of the College, in 1911, the results of this thesis work began to appear in the College Journal. And ever since that time theses, in more or less original form, have constituted the main body of material published in the PHILIPPINE AGRICULTURIST. Amongst the agricultural colleges of the Tropics the twenty-two volumes to date of this publication may reasonably claim to be an unique monument to this type of work.

In spite of the other heavy duties carried by most of the faculty, in spite of the lack of elaborate equipment and facilities that so many researchers feel are essential for any research, and in spite of the transient tenure of so many of our staff, this astonishingly large amount of sound and useful research work has been carried out here on our Campus.

The basic idea has been that every student before graduating from the College must present a thesis based upon original research and representing a real contribution to science. The student is expected to devote to this work not less than five units or ten laboratory

hours a week for two semesters. Oftentimes much more time than this is necessary, for the student must complete the problem, not merely fulfill the time requirements. No grades are given in thesis work; instead, the adviser reports the work as "satisfactory" or "unsatisfactory". If a student exerts himself conscientiously, even though difficulties in the work prevent much progress, the former remark is recorded. On the other hand, if the student does not try, and the remark, "unsatisfactory" is twice recorded, he must drop the problem. He then usually tries thesis work in some other department of the College. The student has always been more or less free to specialize and take his thesis in any one of the different departments of the College, except in the purely academic department of English and modern languages. But once he has selected his major study, he must follow it rather closely, and take the related advanced subjects offered.

With these high requirements the thesis can only be a joint undertaking of faculty adviser and student: an arrangement that stimulates both parties, one that supplies the adviser with an assistant who is able and willing to work hard for many months without wages; and in return for this, in the final preparation of the manuscript, the best facilities of the whole campus are at the disposal of both adviser and student—a far more effective way of accomplishing worth while results, particularly in a pioneer field, than leaving to the initiative of the faculty the preparation of papers upon their own personal research.

The earlier theses did not follow a definite form, as the more important and the really essential point was to present new data, a contribution to science. Results, recorded as a basis for local instruction, and for further research, were rightly the main interest of our pioneers. Professor Yule tells of some of her almost insuperable difficulties in trying to prepare for publication some of the earlier theses. It was after nearly a decade of thesis work that Dr. S. F. Trelease joined our faculty and for a time became editor of this Journal. His trials as editor in preparing thesis material for printing caused him to work actively toward the development of a policy that would ensure that the theses at the time of acceptance by the College would be in a suitable form for publication, whether or not the material of the entire thesis presented in all cases was worthy of being published. Professor Trelease lead in the development of the model form, and Professor Yule coöperated in the compilation and by teaching in the English courses the methods and

manner of preparing thesis manuscripts. From this beginning developed the well known Trelease and Yule manual, *Preparation of scientific and technical papers.*

To meet changing conditions, from time to time the details of the procedure of preparing theses have been altered somewhat, but the main features of the scheme remain essentially as developed considerably over a decade ago. So useful has this general form of presenting scientific material proved that it is invariably followed with all the theses submitted, and frequently it is followed by our graduates in their report writing.

The actual steps that must be taken in the thesis work to enable the student to have his work approved, to obtain credit, and to be graduated, are as follows: Within a month after registration for thesis work, the student must prepare an outline of the proposed study. Before this he will have discussed the subject at considerable length with the adviser he has selected, and this adviser will have suggested readings in line with the proposed work. The outline, itself, follows a very definite form, and must be in considerable detail. After approval by the adviser and the head of the department, and the Dean, quadruplicate copies with signatures are filed in the Secretary's office. One copy is retained there, and the others are returned to the department head, the adviser, and the student.

The thesis work is carried out under the direction of the adviser, often with much help and supervision. Different advisers and department heads use different means to satisfy themselves that the work is honestly and faithfully executed. The original outline as filed must be followed faithfully, even if, as so often happens, other attractive and unexpected lines of work open out as the problem progresses, and the new developments seem to be much more profitable and interesting than the original problem contemplated and undertaken. Such new possible developments can often be given to another thesis student, so that such stimulus and correlation of work is not lost.

When it comes time to write the thesis, the average student usually does not need any great amount of help from the adviser, for the general thesis form is well developed in many theses on file in the College Library, and in those in print, and it is not usual that the subject of the thesis under preparation is so entirely new that material assistance and suggestion cannot be obtained. Sometimes, however, since for most of our students English is a foreign language and not the mother tongue, a thesis student, though an honest and very hard and capable worker, producing a mass of

valuable data, is quite incapable of writing his thesis in acceptable form. Then the adviser takes the material, and working steadily with the student, puts the material into presentable form, for it is imperative that the paper when sent on to the critic be a workmanlike product. The draft thesis must now be typed. It is usual at this point to consult the English Department as to the form and headings of the tables, and to have the necessary tables typed at once in quadruplicate, sending with the draft to the critic one of the copies of the tables.

After the thesis has been approved by the adviser and the head of the department, the student takes the manuscript to the Dean of the College, who appoints a critic. The critic is a member of the faculty and in another department from that in which the thesis work was done; usually one familiar with the subject, though from another angle. The critic studies the thesis, and then goes over it with the student, making sure that the presentation is clear, and that the discussion and conclusions conform to the data presented. Any doubtful points are cleared up, usually the student is able to do this unaided, and to make the slight modifications desired in the presentation. Sometimes the student must consult his adviser to make the adjustments that the critic thinks desirable, and there may be a conference between critic, adviser and student. Usually, the paper is well prepared, for knowledge that the paper will have to meet the approval of some critic as yet unappointed, makes the adviser careful to see that the work has been well done from the first, and that the presentation is sound and clear. It is not often that points raised by the critic are at all serious, and frequently the only matters needing clarification are those that are obscure because the critic is not perfectly familiar with the particular field of study being reported upon.

If the work appears to the critic to be glaringly faulty, he may reject the thesis, in which case it goes back to the department concerned, with a statement of the objections. If the objections are deemed valid by the department head and the adviser, the student is directed and assisted to make good the defects, and perhaps after months of work and perhaps entirely rewriting the thesis, it is again presented to the critic for approval. In the few cases where the adviser feels that there has been an unjust rejection by the critic, through unfamiliarity with the field, or in the very rare cases where personalities arise, the adviser may appeal to the Dean over the rejection of the critic. The Dean may settle the disagreement or

will appoint a referee, who will review the case and make recommendations, upon the merits of the work presented, either for acceptance or modification of the work or improved presentation.

After approval by the critic, the draft copy of the thesis is read in the English Department, and the English and general form corrected. After "reading for English" is completed, the thesis is taken by the student to the dean of the college. Usually the decision of the critic is sustained and the thesis approved, though occasionally a thesis although approved by the critic is rejected by the dean. When approved by the Dean the draft thesis is retyped in quadruplicate in final form, and as a protection against typist's errors is again read in the English Department. The first copy is bound and filed in the College Library, the first carbon copy is for editorial use, the second carbon copy for the file of the department in which the work was done, and the third copy is kept by the thesis custodian, the Secretary of the College.

The ultimate fate of the thesis may be one of many. If it be a study along a new line, and if the adviser has given much time and attention to the problem and the writing up of the results, the paper may be published entire, and under the joint authorship of adviser and student. On the other hand, if the thesis is one of a number of more or less uniform pieces of work, and has been accomplished with relatively little help from the adviser, the latter may be unselfish enough to let the student receive the full credit for the paper. In other cases the thesis may be very much altered in form, and the paper may be published only under the name of the adviser. At times there may be a considerable number of theses combined together and published as one paper or as a series by the adviser, with the credit due to the student appearing as a footnote. Sometimes the thesis material does not warrant separate publication, and it may be abstracted by some member of an advanced class in English, and only the abstract published in this Journal.

There are a number of interesting things that develop in the thesis work. The selection of the department or branch of work is often not determined by the interest of the student, nor by the line of work that seems to be the most profitable after graduation, but by the question of cost that will be incurred in the thesis work. Some lines of work, such as soil survey, require plenty of muscle and perspiration, but not much cash expenditure; while other lines, particularly some laboratory problems, necessitate heavy expenditure for chemicals or other supplies. In some cases, if the student can

afford it, he voluntarily obtains at his personal expense materials or equipment which will facilitate the work although the equipment is not essential. In other cases the personality of the adviser is the determining factor in the selection of the thesis subject or branch of work by the student.

One of the serious difficulties in thesis preparation is the expense of typing. While the tables need be typed but once, there must be double typing of the text, the final typing necessitating three carbon copies. Very few of our students have personal typewriters, and so must have their theses typed by professional typists, usually clerks in the college. As tables are particularly difficult and expensive to type, it is fortunate that the present practice is to reduce the amount of tabular matter in the theses that is typed to summary tables, keeping the detailed figures, of which there are often vast quantities, on file in the department. Sometimes a poor student is able to have a friend type his thesis and then work off the indebtedness by helping in return with thesis or other work.

Pointing out the pressing need for facts on which to base the instruction of the College, and the need for maintaining research activity amongst the faculty in spite of the inadequacy of equipment and facilities, there has been described the development and present nature of the senior thesis in this College and the important part it plays in stimulating scientific activity and actually producing results. The writer urges that a more or less similar thesis method be adopted by other pioneer agricultural institutions, especially those faced with similar kinds of problems.

ROBERT L. PENDLETON.
Of the Department of Soils

The structure of human betterment cannot be built upon foundations of materialism or business, but upon the bed rock of individual character in free men and women. It must be builded by those who, holding to ideals of its high purpose, using the mold of justice, lay brick upon brick from the materials of scientific research, the painstaking sifting of truth from collections of facts and experience, the advancing ideas, morals and spiritual inspirations. Any other foundations are sand; any other mold is distorted; and any other bricks are without straw.—HERBERT HOOVER.

SPAWNING AND FEEDING HABITS OF AYUÑGIN, MESOPRISTES PLUMBEA (KNER), A COMMON THERAPONID FISH IN LAGUNA DE BAY [1]

ANDRES M. MANE
Of the Department of Entomology

WITH THREE CHARTS

Ayuñgin is one of the economic food fishes of Laguna de Bay. It is not considered the best, but when other popular food fishes, as kanduli, *Arius* spp. (Ariidae), biyang-puti, *Glossogobius giurus* (Ham.-Buch.) (Gobiidae), and dalag, *Ophicephalus striatus* Bloch (Ophicephalidae), are not easily procured the ayuñgin is a welcome substitute.

The ayuñgin, though eaten fresh, are generally preserved by salting and drying and sold in this form as *tuyo* (dried fish). Ayuñgin may also be made into fine fish meal [2].

The larger food fishes of Laguna de Bay eat the ayuñgin. The worst enemy of this fish, however, is the fresh-water snake, *Chersydrus granulatus* Schneider locally known as duhol. This snake is very common in Laguna de Bay. The set line fishermen use the ayuñgin as bait in catching dalag and kanduli.

Herre (1930) [3] reports that ayuñgin is apparently confined to the Philippines, and that it seems to be found only in fresh water. It abounds in Laguna de Bay in practically every portion of the lake;

---

[1] Experiment Station contribution No. 979. Read before the Los Baños Biological Club on February 25, 1932. Received for publication June 7, 1934.

Thanks are due Dr. Deogracias V. Villadolid for suggesting the problem and for his kind help in the preparation of the manuscript.

[2] Fish meal made from ayuñgin taken from Laguna de Bay was prepared by Dr. Deogracias V. Villadolid and his students in May, 1932. The following is the result of the chemical analysis of this meal by the Department of Agricultural Chemistry:

Moisture, 5.21%; fats (ether extract), 3.85%; ash, 29.39%; protein (N $\times$ 6.25), 59.79; crude fiber, none; carbohydrates (N.F.E.), 1.76%; calories per hundred grams, 288.0.

[3] HERRE, A. W. 1930. Notes upon *Datnia plumbea*, or ayuñgin, Philippine theraponid. Copeia 3: 76–77. (Journal of the American Society of Ichthyologists and Herpetologists.)

its distribution extends to the mountain streams flowing into the lake.

The usual methods of catching ayuñgin in Laguna de Bay are by *baklad-süd* (small fish corral), *sakag* (scissors-nets), *pante* (gill nets), *pukot* (seine nets), and *panaklob* (dip nets).

The objects of the work here reported were: (*a*) to ascertain the time and length of the spawning season of ayuñgin in Laguna de Bay by the examination of the gonads; (*b*) to determine at what time the spawning activity of this fish is at its peak; (*c*) to ascertain the size at which it attains sexual maturity; and (*d*) to make ecological observations on its feeding habits.

The work was begun in April, 1930, and closed in May, 1931, thus covering a period of about fourteen months. Field observations were extended throughout the greater part of 1933. Laboratory studies were undertaken in the Limnological Station at Mayondon, Los Baños. Frequent trips were made to Calamba, which is a large distributing center for Laguna de Bay fish, and to some other portions of the lake for the purpose of making collections and to observe the habits of the fish.

LENGTH MEASUREMENTS

The specimens collected were preserved in ten per cent formalin solution before measurements were made. Length measurements were taken from the tip of the snout to the end of the caudal vertebrae with the aid of a divider and millimeter rule.

MEASUREMENTS OF THE OVA

The diameters of the ova were measured by means of an eyepiece micrometer placed in a compound miscroscope. The diameter was determined by placing the eyepiece micrometer horizontally across the field of the microscope and then reading the diameter across the widest portion.

OBSERVATIONS ON THE FEEDING HABITS

Observations on the feeding habits were made both in the laboratory and in the field. Frequent trips were undertaken in the ayuñgin fishing grounds and in clear streams where the fish could be seen feeding. In the laboratory, the food of the fish was determined by dissecting the stomachs and examining the contents with the aid of a dissecting microscope. The percentage of each food constituent was then computed on the basis of the amount of food found in the stomach of each individual fish. All determinations were volumetric.

RESULTS AND DISCUSSION

Spawning season

Condition of the ova in the mature ovary. In the study of the spawning habits of the fish, examination of ova of a large number of females was made. For purposes of statistical treatment, the ovarian contents were roughly classified as follows: the immature (group I eggs), the intermediate (group II eggs), and the maturing (group III eggs).

The immature class of eggs constituted the largest number of the three kinds of eggs, ranging in diameter from 0.03 to 0.13 millimeter. The mode was 0.05 millimeter, which represented the highest frequency in all the groups. The immature eggs were transparent and appeared to be slightly creamy-white when preserved in formalin solution. This class of eggs was present in the ovaries of sexually mature females throughout the year.

The intermediate class of eggs measured from 0.14 to 0.23 millimeter in diameter. These eggs were, likewise, creamy-white in formalin but were opaque and presented prominent oil globules.

The maturing class of eggs measured from 0.25 to 0.47 millimeter in diameter. The eggs were from light to deep orange in color. When the diameter size limit of 0.47 millimeter was reached, the eggs became free and segregated in the lumen of the ovary, in contrast with the younger eggs which were bound together in connective tissue. The maturing eggs, moreover, could be readily recognized by their characteristic orange color; the maturing and intermediate eggs are transparent creamy-white.

The mature ovary almost fills the cavity behind the stomach, and lies above the intestine. It is very much distended, its walls being thin and widely stretched. The color is orange owing to the reflected color of the eggs inside.

Spawning season. To determine the period of the spawning season, ova were collected and measured at intervals of seven days during the twelve months period from April, 1930, to March, 1931. A portion of the ovary of the individual fish was teased out on a slide and measurements of ova were made at random until the desired number was reached.

The result of this determination is shown in chart 1. Each curve is the result of the average of the measurements of 300 ova taken from ten fish collected at random at each inspection.

From the chart, it will be seen that the fish spawned throughout the year as indicated by the fact that the maturing class of ova was

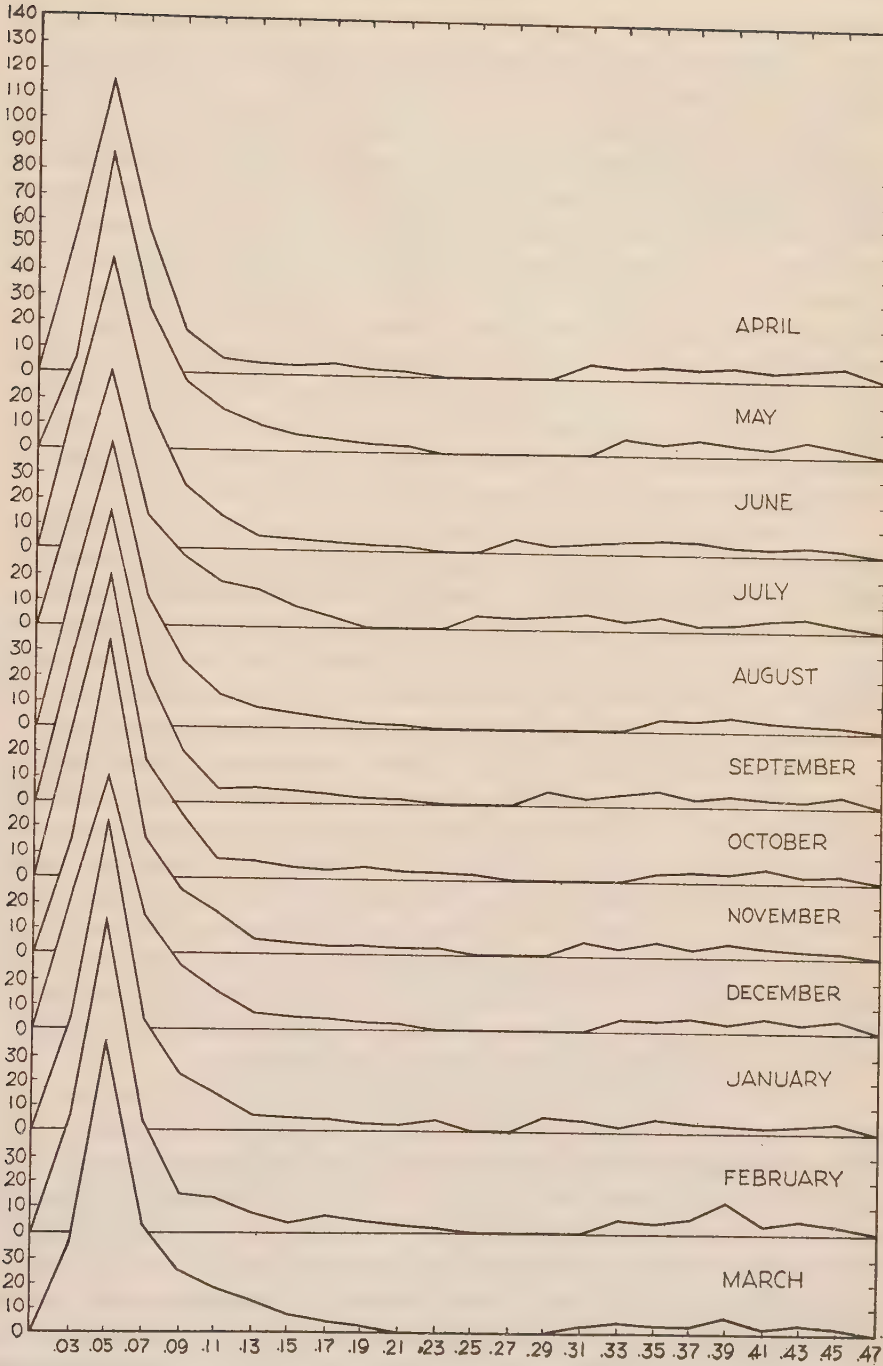


Chart 1.—Frequency curves of diameters of ova during the period from April, 1930, to March, 1931 (ova were taken from 10 fish at 7 days interval).

always present in the ovaries of the fish at all times during the year. The maturing class of ova is found only in individuals which are about to spawn.

From the frequency curves it may be concluded that the rate at which the intermediate class of eggs are derived from the immature group is slow and gradual. This conclusion is indicated by the sudden descent of the frequency curves from the mode. The remainder of the curve from the base of the mode, from 0.09 millimeter to 0.23 millimeter, represents a marked gradual slope. The rate at which the maturing class of eggs is derived from the intermediate class is rapid. This assumption is supported by the break in the continuity of the frequency curves and the marked fluctuations in the remaining parts of the curves from 0.25 to 0.47 millimeter. Eggs having the latter diameter are about to be spawned, as they are usually found loose in the lumen of the ovary.

At any time of the year, when measuring eggs from different individual fish in a single collection, adult females with immature and intermediate groups of eggs were found. There were also found females that carried immature, intermediate and maturing eggs. These differences in the development of the ova in the ovaries of different individual fish at all times of the year probably explain the presence of spawning ayuñgin almost throughout the year.

Peak of spawning activity. After examining a large number of ova, the writer recognized certain criteria which made it possible to differentiate with the unaided eye the ovaries into those that contain immature eggs, intermediate eggs and maturing eggs. Ovaries which contained immature eggs only had ova that could not be seen by the naked eye; those that had intermediate eggs had creamy-white ova large enough to give the gonad a granulated appearance; while ovaries with the maturing eggs had large ova which were orange in color. These criteria were later used in classifying ovaries into immature, intermediate and maturing.

Several series of dissections of sexually mature females were made from April, 1930, to May, 1931, at intervals of seven days. The percentages of the females with maturing ovaries were computed. Chart 2 shows the result. It will be seen that the greatest number of spawning females was found in the samples collected during March, April, and May, being 48.61, 53.96, and 65.34 per cent, respectively. Chart 2 also shows the abrupt ascent of the curve to the mode, which fact indicates the rapid rise in the spawning activity of the fish from January to May. In January, 5.83 per cent of the total number of females examined were about to

spawn. From June to December there was a more or less gradual decrease in the spawning activity of the fish until in December only about 1.76 per cent of the females examined were found to contain maturing eggs. This decrease is shown in the gradual descent of the curve from the mode. Greater spawning during April and May was further indicated by the abundance of very young ayuñgin which were taken in large numbers in the hauls of the *sakag* and

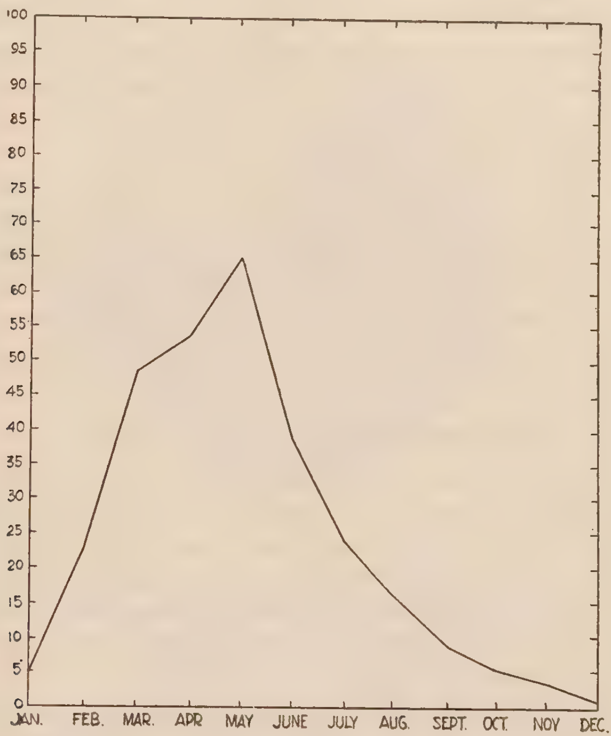


Chart 2.—Average monthly percentages of female ayuñgin with maturing eggs in the samples collected at seven-day intervals from April 5, 1930, to March 25, 1931.

siid. The young ayuñgin in the catches of these fishing nets and traps are usually thrown away after the larger fish have been sorted out to be sold.

Size at sexual maturity

In determining the size at which the fish becomes sexually mature, dissections of 5,060 individuals were made during the three months from April, to June, 1931. The fish used in this determination represented the smallest from those collected by the writer up

to the largest caught by the commercial fishermen. The presence of the maturing class of eggs in the female and the well developed testis with mature spermatozoa in the male were used as criteria to indicate the sexual maturity of the fish. Table 3 presents the results of this determination.

Of the 2,817 females dissected, 2,145 were mature and 672 were immature. The female ayuñgin begins to mature at from 4.1 to 7.0 centimeters. About 9.09 per cent of the female fish dissected were mature at 4.2 centimeters; about 15.49 per cent at 4.8 centimeters; about 15.49 per cent at 5.2 centimeters; about 84.15 per cent at 5.8 centimeters; about 88.75 per cent at 6.2 centimeters and about 89.10 per cent at 7.0 centimeters. All fish above 7.0 centimeters were found to be sexually mature.

Of the 2,243 males dissected, 2,067 were mature and 176 were immature. The males were found to mature at a size group of 3.6 to 5.5 centimeters long. About 8.7 per cent of the dissected males were mature at 3.8 centimeters; about 27.74 per cent at 4.2 centimeters; about 71.43 per cent at 4.8 centimeters; and about 98.57 per cent at 5.2 centimeters. Invariably, all male fish longer than 5.6 centimeters were found to be mature.

Food and feeding habits of ayuñgin

The fish used in this determination were taken from the collections made near Mayondon shore and in the fishing grounds around Talim Island and from the water bordering Sukat, Rizal. The fish were put in ten per cent formalin solution as soon as they were caught. In this way further digestion of the food in the stomach was prevented. Thus, in most instances the food in the stomachs could be found whole.

Ten well filled stomachs were opened and examined each month from April, 1930, to March, 1931. Table 4 and chart 3 show the results of the examination.

Vegetable food. Vegetable matter was found in the stomachs of ayuñgin to the amount of 48.84 ± 2.58 per cent of the total annual consumption. This food item was taken throughout the year from April, 1930, to March, 1931. The vegetable food of the fish consisted of filamentous algae (mostly Cladophora) and unicellular algae, locally called lia (*Microcystis aeruginosa* Kützing[4]). The majority of ayuñgin taken in Sukat, Rizal, in May, 1931, had their stomachs filled with lia.

---

[4] Identified by Dr. G. Smith of Leland Stanford University, through Dr. José B. Juliano.

There was at this time large deposits of partly decomposed algae on this shore.

Ayuñgin were usually found in abundance on rocky shores feeding in the crevices and in places where there was plenty of filamentous algae. This was especially true on the shores of Talim Island. In collecting samples from this place, the fish were cornered in the crevices of stones. In the mouths of rivers, where the water was quite clear, ayuñgin were observed feeding on the growing algae.

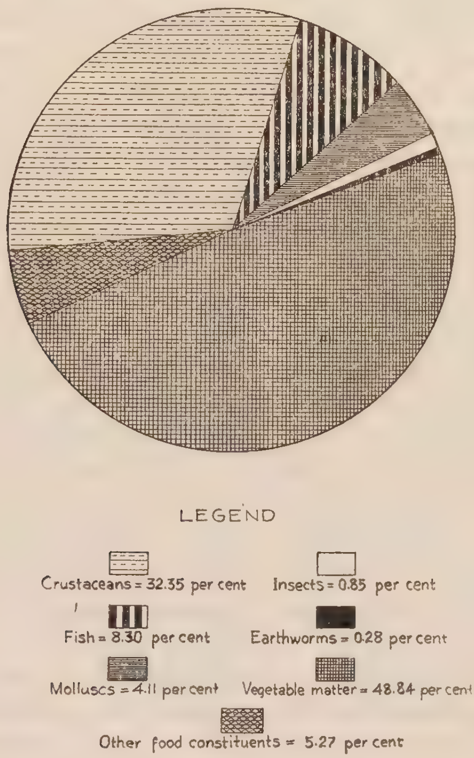


Chart 3.—Averages of the different food constituents found in the stomachs of ayuñgin during the period from April, 1930, to March, 1931.

Crustacean food. Of the animal food taken from the stomachs of the ayuñgin, crustaceans ranked first in bulk. Crustaceans (mostly *Palaemon* spp., *Atya* spp., copepods and cladocerans) consisted of about 38.35 ± 0.94 per cent of the total annual consumption. The difference of 24.05 ± 3.16 per cent in the amount of this item in the fish food, which ranked second in importance of the

diet, is significant. Crustaceans were found in the stomachs of the fish throughout the year.

Fish food. Fish food ranked second in bulk as food of the ayuñgin. This food item constituted about 8.30 ± 1.18 per cent of the total bulk. The difference of 4.19 ± 1.27 per cent from that of the snails taken, which was next in importance as animal food, is significant. The species of fish found was *Mirogobius lacustris* Herre, locally known as dulong. Dulong was taken from the stomachs of ayuñgin during the months from January to October, 1931.

Molluscan food. Molluscs ranked third in bulk as animal food of the ayuñgin. The amount consumed was 4.11 ± 0.4673 per cent of the total annual consumption. The difference of 3.26 ± 0.48 per cent from the insect food which was next in importance as animal food is significant. The species of snails taken were *Melania scabra* Müller, *M. pantherina* von dem Busch, and *Planorbis philippinarum* Dunker.

Insect food. Insects were represented in the stomachs of ayuñgin to the amount of 0.85 ± 0.13 per cent of the total bulk of the food consumed by the fish. The difference of 0.57 ± 0.02 per cent from the worms, which was the least represented in the diet of ayuñgin, is significant. The insects represented were chironomid larvae and larvae of water beetles. The insects were eaten by the fish during June, July, August, and December, 1930.

Earthworms. Earthworms were represented the least of any food in the stomachs of ayuñgin. They constituted about 0.28 ± 0.14 of the total bulk of food taken. The earthworms were found in the stomachs during May, 1930, and August, 1931.

Other food constituents. A small amount of mud and sand was also found in the stomachs of the ayuñgin and calculated to be about 5.27 ± 0.59 per cent of the total bulk. These materials were probably taken in accidentally with the other food items.

SUMMARY AND CONCLUSIONS

(1) Ayuñgin is a commercial food fish which is found in abundance in Laguna de Bay and its tributaries. It is generally preserved by salting and drying and is sold in the market as *tuyo*. It is an important food upon which the larger food fishes depend and is used by the fishermen as bait for set lines. Large ayuñgin are sold fresh and regarded as satisfactory fish for the table.

(2) The ayuñgin, *Mesopristes plumbea* (Kner) is apparently found only in the Philippines, and is confined to the fresh water

lakes and streams. Dr. A. W. Herre, formerly of the Philippine Bureau of Science, and at present connected with Stanford University, confirms this assumption.

(3) The rate at which the intermediate class of eggs which are derived from the immature group by the process of growth and development is slow and fairly gradual; while the rate at which the maturing class is derived from the intermediate is rapid.

(4) Ayuñgin apparently spawns almost throughout the year. This prolonged period of spawning is explained by the fact that different individual fish do not develop eggs to maturity at the same time.

(5) The peak of spawning activity occurs in the height of the dry season, during March, April and May. There is a rapid increase in the spawning activity from January to May and a gradual decrease from June to December.

(6) The female ayuñgin begin to mature at a group-length of 4.1 to 7.0 centimeters with an average length of 5.5 centimeters; the male fish attain sexual maturity at a group-length of 3.6 to 5.5 centimeters with an average length of 4.0 centimeters.

(7) Ayuñgin is omnivorous. The total yearly consumption of vegetable and animal food is about the same. The vegetable matter eaten by the fish consists of filamentous algae (mostly Cladophora) and lia (*Microcystis aeruginosa* Kützing), the most common species of unicellular algae in Laguna de Bay. The animal food consists of the following items, arranged approximately in the order of their bulk: crustaceans (mostly prawns, *Palaemon lanceifrons* Dana, *Atya* spp., copepods, and cladocerans); fish (*Mirogobius lacustris* Herre); snails, (*Melania scabra* Müller, *M. pantherina* von dem Busch, and *Planorbis philippinarum* Dunker); insects (mostly chironomid and water beetle larvae); and earthworms.

TABLE 1

Showing the diameter frequencies of ova during a period of twelve months from April, 1930, to March, 1931 (ova were taken from 10 fish at 7 days intervals)

CLASS VALUE DIAMETER OF EGGS	DIAMETER FREQUENCY											
	1930									1931		
	April	May	June	July	August	September	October	November	December	January	February	March
cm.												
0.021 - 0.040	53	34	60	54	60	62	58	47	53	45	45	37
0.041 - 0.060	113	113	115	100	112	114	121	128	112	122	123	116
0.061 - 0.080	57	54	44	42	50	53	47	46	44	42	42	42
0.081 - 0.100	17	28	27	28	26	21	22	23	25	22	16	26
0.101 - 0.120	7	18	12	18	12	7	9	17	15	17	12	19
0.121 - 0.140	6	10	6	13	8	6	8	7	8	7	8	12
0.141 - 0.160	3	8	4	8	6	5	6	3	6	5	4	8
0.161 - 0.180	4	4	3	6	3	3	3	3	5	6	6	3
0.181 - 0.200	2	2	2	0	2	2	3	2	3	2	4	2
0.201 - 0.220	1	2	1	0	1	1	2	2	1	1	3	0
0.221 - 0.240	0	0	0	0	0	0	1	1	0	2	2	0
0.241 - 0.260	0	0	0	6	0	0	1	0	0	0	0	0
0.261 - 0.280	0	0	5	2	0	0	0	0	0	0	0	0
0.281 - 0.300	0	0	1	3	0	5	0	0	0	7	0	0
0.301 - 0.320	7	0	2	5	0	1	0	7	0	6	0	3
0.321 - 0.340	3	7	5	2	0	4	0	2	5	2	6	7
0.341 - 0.360	7	4	1	3	5	5	2	6	3	5	3	5
0.361 - 0.380	2	7	5	1	2	1	4	1	6	3	5	3
0.381 - 0.400	5	3	3	1	7	4	2	3	1	2	11	9
0.401 - 0.420	2	1	1	3	3	3	7	2	7	1	2	2
0.421 - 0.440	4	3	2	3	2	1	2	1	2	1	5	4
0.441 - 0.460	7	2	1	2	1	2	2	1	4	2	2	2
Total	300	300	300	300	300	300	300	300	300	300	300	300

TABLE 2

Showing the percentages of female ayuñgin with maturing eggs in the samples collected at seven-day intervals from April 5, 1930, to March 25, 1931

DATE	FEMALES EXAMINED	FEMALES WITH MATURING EGGS		MONTHLY AV. OF FEMALES WITH MATURING EGGS
1930	*number*	*number*	*per cent*	*per cent*
5-IV	191	115	60.49	
12-IV	183	98	53.49	53.96
19-IV	139	71	51.22	
26-IV	131	66	50.62	
3-V	162	109	67.02	
10-V	172	113	65.88	
17-V	165	125	75.64	65.34
24-V	162	93	57.33	
31-V	148	90	60.81	
7-VI	139	69	50.00	
14-VI	152	52	34.21	39.44
21-VI	162	70	43.21	
28-VI	182	55	30.34	
5-VII	126	32	25.40	
12-VII	97	27	28.13	24.49
17-VII	54	12	22.58	
24-VII	66	14	30.34	
1-VIII	76	15	19.70	
8-VIII	83	13	16.22	
15-VIII	126	22	17.65	17.32
22-VIII	93	15	14.87	
29-VIII	88	16	18.18	
5-IX	74	7	9.86	
12-IX	85	6	7.35	9.99
19-IX	103	14	13.25	
26-IX	64	6	9.52	
3-X	54	4	7.20	
10-X	68	3	4.69	5.53
17-X	82	4	4.67	
25-X	63	2	3.57	
1-XI	74	3	3.53	
8-XI	87	4	4.92	
15-XI	56	2	2.82	4.24
22-XI	93	4	3.95	
29-XI	78	5	5.97	
5-XII	45	2	2.67	
12-XII	48	0	0.00	1.76
19-XII	56	1	1.76	
26-XII	62	0	0.00	
1931				
1-I	66	3	4.55	
8-I	71	2	2.82	
15-I	79	4	5.06	5.83
22-I	80	7	8.75	
29-I	67	5	7.94	
5-II	82	15	18.29	
12-II	78	12	15.38	23.37
19-II	84	27	31.65	
26-II	72	20	28.17	
4-III	63	29	46.38	
11-III	72	34	47.62	48.61
18-III	36	25	43.75	
25-III	49	28	56.72	

TABLE 3

Showing the size groups of sexually mature ayuñgin

LENGTH OF FISH	FEMALE				MALE			
	Mature		Immature		Mature		Immature	
cm.	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*
1.1 – 2.0	—	—	—	—	—	—	—	—
2.1 – 2.5	—	—	15	100.00	—	—	—	—
2.6 – 3.0	—	—	24	100.00	—	—	—	—
3.1 – 3.5	—	—	39	100.00	—	—	45	100.00
3.6 – 4.0	—	—	45	100.00	6	8.70	66	91.67
4.1 – 4.5	6	9.09	60	90.91	15	21.74	54	78.26
4.6 – 5.0	33	14.29	180	85.71	45	71.44	8	28.56
5.1 – 5.5	192	53.70	159	46.30	197	98.57	3	1.43
5.6 – 6.0	462	84.15	87	15.85	426	100.00	—	—
6.1 – 6.5	450	88.76	57	11.22	408	100.00	—	—
6.6 – 7.0	309	98.11	6	1.89	360	100.00	—	—
7.1 – 7.5	216	100.00	—	—	240	100.00	—	—
7.6 – 8.0	129	100.00	—	—	144	100.00	—	—
8.1 – 8.5	72	100.00	—	—	54	100.00	—	—
8.6 – 9.0	48	100.00	—	—	48	100.00	—	—
9.1 – 9.5	30	100.00	—	—	24	100.00	—	—
9.6 – 10.0	54	100.00	—	—	30	100.00	—	—
10.1 – 10.5	45	100.00	—	—	15	100.00	—	—
10.6 – 11.0	36	100.00	—	—	18	100.00	—	—
11.1 – 11.5	18	100.00	—	—	21	100.00	—	—
11.6 – 12.0	30	100.00	—	—	16	100.00	—	—
12.1 – 12.5	9	100.00	—	—	—	—	—	—
12.6 – 13.0	3	100.00	—	—	—	—	—	—
13.1 – 13.5	3	100.00	—	—	—	—	—	—
13 6 – 14.0	—	—	—	—	—	—	—	—

TABLE 4

Showing the monthly range of stomach contents of ayuñgin

FOOD	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANNUAL AVERAGE
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Crustaceans	10.28	13.27	26.50	19.50	29.26	47.12	58.32	53.18	33.72	24.16	35.87	37.00	32.35 ± 2.9366
Fish	11.44	16.39	8.30	12.28	19.21	10.23	5.26	9.05	2.88	5.21	—	—	8.30 ± 1.1848
Molluscs	4.65	1.86	0.70	5.32	5.32	5.15	2.33	2.13	6.49	8.35	6.83	3.76	4.11 ± 0.4673
Insects	—	—	1.00	—	—	2.47	3.45	2.02	—	—	—	1.27	0.85 ± 0.1267
Earthworms	—	—	—	—	2.25	—	—	1.08	—	—	—	—	0.28 ± 0.1351
Vegetable matter	67.36	64.35	60.37	60.72	38.30	33.23	30.34	30.18	47.43	53.83	48.37	51.63	48.84 ± 2.5802
Other food constituents	6.27	4.23	3.13	5.20	5.66	1.80	0.30	2.36	10.08	8.45	8.93	6.34	5.27 ± 0.5869
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	—

CHEMICAL ANALYSIS OF SOME IMPORTANT VARIETIES OF TOBACCO GROWN IN THE PHILIPPINES [1]

Felipe E. Crisostomo

Tobacco like other plants undergoes complex chemical changes during its production. Literature reveals that some chemical constituents are correlated to some definite tobacco qualities, hence, data on the chemical analysis of tobacco varieties may be of help to investigators.

REVIEW OF LITERATURE

In curing tobacco, several changes take place, which according to Behrens (1895) as cited by Lava and Etorma are as follows: "(*a*) the dry weight decreases; (*b*) the salts of organic acids increases; (*c*) the nitrogenous substances decrease, although the amids increase and the nicotine content does not change; (*d*) the ethereal oil evaporates; and (*e*) the salts of sulfuric acid increase." These take place during the first stage of curing; during the later stages, the same author gives the following as the changes taking place: "(*a*) the dry weight decreases because of loss in carbohydrates and organic acids; (*b*) a part of the nicotine disappears; (*c*) the nitric acid is completely eliminated; (*d*) asparagin disappears, while amino acids appear; (*e*) the weight of ether extractable substances is decreased; and (*f*) a gaseous substance (possibly butyric acid) is formed."

Garner (1907) in his study on the relation of the chemical composition to the burning qualities of tobacco, states that the fire-holding capacity is dependent primarily on the content of potash combined with organic acids, but chlorine, sulfates and a large amount of magnesia injure the fire-holding capacity. In case of the sulfate, the effects are not so marked when it is in combination with potash. The lime content does not greatly affect the fire-holding capacity but it is an essential factor in the production of good ash. With the possible exception of the so-called tarry acids and al-

---

[1] Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 426; Experiment Station contribution No. 980. Prepared in the Department of Agricultural Chemistry under the direction of Mr. Ramon A. Cruz.

buminoids, none of the organic constituents of tobacco exert a very important influence on the burning quality.

According to Garner (1909) matured tobacco leaf is very rich in starch, and one of the important changes in the curing is the disappearance of this starch which is consumed by the living portion of the leaf itself. If the leaf is killed by bruising, rapid drying or heating too high, there is no means of removing this starch and the tobacco is harsh, lifeless and "strawy".

In their study of fertilizer treatment of tobacco, Ames and Boltz (1915) arrived at the conclusion that the composition of tobacco is modified to a great extent by different fertilizers and different treatments. As a rule, tobacco from limed plots contains less phosphorus, potassium and sulfur than that from unlimed plots, and organic carriers of nitrogen produced tobacco with higher nitrogen content than when inorganic carriers were applied.

Quoting Lava and Etorma, "According to these investigators, (De Vries and Sidenius, 1916) the greater the duration of the glow and the whiter the ash, the better is the quality of tobacco. Furthermore, tobacco of superior quality contains less ash (total percentage), and less chlorine and SiO_2 in the ash."

Gonzalez (1919) found that legumes turned under in tobacco field gave low nicotine content and long average duration of glow to the tobacco leaf. He concluded that organic fertilizers are good to secure low nicotine content and long duration of glow, while double superphosphate and sulfate of ammonia increase the nicotine content.

Graham and Carr (1924) stated that the aroma is not closely related to the amount of nicotine contained in the plant. Nicotine compounds are quite basic and seem to act like the corresponding compounds of ammonia, being volatile in some combinations and non-volatile in others. So nicotine in the free state or as nicotine tannate, acetate or some loose combinations are volatile, whereas nicotine malate, citrate and oxalate are non-volatile and insoluble in petroleum ether. The vegetable waxes, volatile oils and loosely combined nicotine contained in petroleum extracts are responsible for much of the irritating effect of the tobaccos grown.

Schmuck and Balabuha-Popzowa (1927), as cited by Lava and Etorma, arrived at the conclusion that: "(*a*) the amount of carbohydrates together with that of polyphenols increases in the samples of tobacco of higher quality; (*b*) the amount of protein and total nitrogen decreases in the samples of better quality while the nicotine content and the ash content increase in tobacco of inferior quality;

(*c*) the ratio of total carbohydrates to the protein is a good index of the quality of tobacco, the higher ratio indicating tobacco of superior quality; (*d*) dark colored tobaccos contain a greater amount of nicotine, protein, and total nitrogen and less carbohydrates and phenols than lighter colored tobaccos, the latter being, therefore, superior in quality to the former."

According to Lava and Etorma (1929), Garner and Bacon and others concluded from their experiments that the starch is first transformed into sugars, which in turn, is transformed into oxalic citric and malic acids, which finally decompose into carbon dioxide and water.

OBJECT, TIME AND PLACE OF THE PRESENT STUDY

The object of the present study was to present data on the chemical constituents of some of the important varieties of tobacco grown in the Philippines.

The work was carried out in the Department of Agricultural Chemistry of the College of Agriculture, University of the Philippines from March, 1932 to February, 1933.

MATERIALS AND METHODS

Materials

Varieties of tobacco used. The following varieties of tobacco were used:

1. Echague
2. Improved Gold Leaf College No. 7808
3. Romero
4. San Antonio
5. Long Leaf Gooch Tobacco
6. White Stem Orinoco
7. Ax-hybrid Flue-cured
8. Baker Sumatra Wrapper Tobacco
9. Gx-hybrid Wrapper Tobacco
10. Hx-hybrid Wrapper Tobacco
11. Ix-hybrid Wrapper Tobacco
12. Jx-hybrid Wrapper Tobacco
13. Ilagan Sumatra Wrapper Tobacco
14. 10A-hybrid Wrapper Tobacco
15. 10B-hybrid Wrapper Tobacco
16. Medium Fine Wrapper Tobacco

The first four varieties were verified by Dr. V. C. Calma of the Department of Agronomy. The other twelve were verified by Dr. Domingo Paguirigan and his assistant, Mr. Jose Ramos, of the Tobacco Division, Bureau of Plant Industry.

Sources. The first four varieties were obtained from a caiñgin on the base of Mount Maquiling, bordering the College Farm. The others were secured from the Bureau of Plant Industry through Dr. Felipe T. Adriano. They came from three different places: varieties 5 and 6 came from Alabang, Rizal; 7 to 15 from Ilagan, Isabela; and 16 from Amuling, Nueva Vizcaya.

Sampling. The first four varieties were dried in the Agricultural Chemistry thesis room under ordinary conditions using *palillos* (sharpened sticks). At the end of the fifth week, the midribs were removed and the remaining portions of the leaves were chopped fine and thoroughly mixed and placed in air tight jars ready for analysis.

The twelve varieties from the Bureau of Plant Industry were cured when received. Samples were prepared from them and kept in the same manner as the samples from the other varieties.

Methods of analysis

In determining the constituents, the directions given in the *Official and Tentative Methods of Analysis*, (1930) were followed. The constituents determined were: moisture, total ash, crude fats or ether extract, crude fiber, water soluble reducing sugars, starch, total nitrogen, nicotine, silica, iron, aluminum, magnesium, calcium, sodium, potassium, phosphorus, sulfur and chlorine.

RESULTS AND DISCUSSION

The results of the analyses are shown in tables 1, 2 and 3 for both organic and inorganic constituents. The figures are averages of at least two concordant determinations.

Moisture. The varieties of tobacco locally collected had a moisture content (table 1) ranging from 9.90 to 12.17 per cent. Those that came from Alabang, Rizal; namely, Long Leaf Gooch Tobacco and White Stem Orinoco had a moisture content of 19.42 and 23.01 per cent, respectively. Those that came from Ilagan, Isabela, all of which are wrapper tobacco, with the exception of Ax-hybrid Flue-cured, had a moisture content ranging from 17.25 to 20.24 per cent. Medium Fine Wrapper which came from Amuling, Nueva Vizcaya contained 19.36 per cent. These differences in moisture content may be due to the different conditions under which the different samples of tobacco were subjected.

Ash. Examination of the figures in table 2 will show that total ash was higher than the rest of the constituents in all samples except in variety Long Leaf Gooch Tobacco. Tobacco varieties which

came from Ilagan, Isabela and those called wrappers were higher in ash than the Ax-hybrid Flue-cured which came from the same place. According to De Vries and Sidenius, as quoted by Lava and Etorma, tobacco of superior quality contains less ash than the inferior. If this component be considered in the samples as grouped, the following may be selected: Echague and Romero for the locally collected samples, Long Leaf Gooch and White Stem Orinoco, the two varieties that came from Alabang, Rizal and Ax-hybrid Flue-cured of those that came from Ilagan, Isabela.

Crude fiber. Excluding ash, crude fiber was found to be the highest of the components determined, except in varieties, Romero, Long Leaf Gooch Tobacco and White Stem Orinoco.

Starch, water soluble reducing sugars, ether extract and total nitrogen. No general tendencies were noticeable in the differences obtained for figures on starch, water-soluble reducing sugars, ether extract or total nitrogen in the tobacco varieties analyzed, except in variety Long Leaf Gooch Tobacco. This variety, as may be seen in table 2, is higher in starch and water-soluble reducing sugars than White Stem Orinoco the other variety which came from Alabang. If, as Garner and Bacon and others concluded, as cited by Lava and Etorma, the starch is first transformed into sugars which in turn are transformed into oxalic, citric and malic acids, which finally decompose into carbon dioxide and water, it may be considered that the Long Leaf Gooch Tobacco may not have been cured properly or that it may be naturally high in those constituents. The first supposition is in accordance with Garner (1909) who stated that if the leaf is killed by bruising, rapid drying or heating at too high temperature, there is no means of removing this starch. Ix-hybrid Wrapper Tobacco contains the highest crude fiber (18.38 per cent) among the samples that came from Ilagan, Isabela.

Nicotine. Nicotine was found to vary from 1.58 to 4.49 per cent for the locally collected tobacco varieties, from 1.32 to 3.31 per cent for varieties that came from Alabang, Rizal and from 1.41 to 3.90 per cent for varieties that came from Ilagan, Isabela. A superior quality of tobacco contains the less nicotine, according to Schmuck and Balabuha-Papzowa (1927), as cited by Lava and Etorma. For this constituent, Improved Gold Leaf College No. 7808 for locally collected samples, White Stem Orinoco of the varieties which came from Alabang, Rizal and Gx-hybrid Wrapper Tobacco, and Ax-hybrid Flue-cured for the varieties which came from Ilagan, Isabela may be listed as the best of the varieties analyzed.

Examining the results of inorganic constituent determinations based on the ash as given in table 3, it may be seen that silica was low in variety Romero of the first four samples, and Jx-hybrid Wrapper Tobacco of samples that came from Ilagan, Isabela. A superior variety of tobacco, as concluded by De Vries and Sidenius (1916), cited by Lava and Etorma, contains the less ash. For this component the two varieties, Romero and Jx-hybrid Wrapper Tobacco may be selected.

Iron and aluminum. No reference was found in the literature consulted as to iron and aluminum in relation to the other elements connected with a superior quality of tobacco. These two components were found to be variable in the samples analyzed.

Calcium. Calcium was generally higher than magnesium in all the samples of tobacco analyzed, and also higher than the rest of the components, with the exception of potassium and phosphorus, in variety Ix-hybrid Wrapper Tobacco. Of the first four varieties studied, it was found high in Improved Gold Leaf College No. 7808 and Romero; in White Stem Orinoco for the two varieties from Alabang, Rizal. If high calcium content is desired, which, according to Garner (1907), does not greatly affect the fire-holding capacity but it is an essential factor in the production of good ash, these three varieties may be selected. Variety San Antonio of the locally collected samples and Ix-hybrid Wrapper Tobacco for the samples which came from Ilagan, Isabela were noticeably low in this component.

Magnesium. Magnesium was found to be comparatively low in Echague of the locally collected varieties, in White Stem Orinoco for the two varieties from Alabang, Rizal and in Ax-hybrid Flue-cured, Baker Sumatra Wrapper Tobacco and 10B-hybrid Wrapper Tobacco for the varieties from Ilagan, Isabela. A large amount of magnesia injures the fire-holding capacity, according to Garner (1907). If low magnesium content is desired, the varieties named above may be selected.

Sodium. Sodium was found to vary from 2.98 to 8.76 per cent in the first four varieties, and almost the same in the two samples from Alabang, Rizal, and varied from 2.47 to 7.46 per cent in the samples collected in Ilagan, Isabela. No reference was found in literature consulted as to the effect of these constituents on tobacco qualities.

Potassium. In all samples, potassium was found to be higher than sodium. With the exception of calcium and silica it was also

higher than the rest of the inorganic constituents, except chlorine and phosphorus in varieties Baker Sumatra Wrapper Tobacco, phosphorus in Jx-hybrid Wrapper Tobacco, and sulfur and chlorine in San Antonio. Examining the varieties as grouped, potassium was found high in Echague of the first four varieties; in White Stem Orinoco, and in Hx-hybrid Wrapper Tobacco, Ix-hybrid Wrapper Tobacco and 10B-hybrid Wrapper Tobacco from Ilagan, Isabela. According to Garner (1907) the bad effect of sulfate on fire-holding capacity is lessened if it is in combination with potash. If potassium is desired, the varieties mentioned within the group may be selected.

Phosphorus. No statement can be made as to the general behavior of phosphorus content. It was found variable in the different groups of tobacco samples, ranging from 5.42 to 10.74 per cent for the first four samples collected; 9.35 and 10.97 per cent for the two samples from Alabang, Rizal and from 4.71 to 21.74 per cent for varieties from Ilagan, Isabela, and 8.05 per cent for the variety which came from Amuling, Nueva Vizcaya.

Sulfur. Sulfur was found more widely variable in local samples with percentages ranging from 2.70 to 14.72 per cent, than in the groups from other places. Sulfur content of varieties Romero and Improved Gold Leaf College No. 7808 may be considered low for the first group and in White Stem Orinoco of the two varieties from Alabang, Rizal and Hx-hybrid Wrapper Tobacco, Ax-hybrid Flue-cured, Baker Sumatra Wrapper Tobacco, Ilagan Sumatra Wrapper Tobacco and Jx-hybrid Wrapper Tobacco for varieties which came from Ilagan, Isabela. If Garner's finding that sulfate and a large amount of magnesia injure the fire-holding capacity, tobacco varieties with the less sulfur content should be selected. Medium Fine Wrapper Tobacco and the varieties mentioned above may be selected as having that constituent.

Chlorine. Chlorine may be considered as low in Improved Gold Leaf College No. 7808 of the first four varieties and variable in samples which came from Ilagan, Isabela with a range of from 5.10 to 19.61 per cent. For this group the following varieties may be considered as low in this constituent; Ix-hybrid Wrapper Tobacco, Hx-hybrid Wrapper Tobacco, Gx-hybrid Wrapper Tobacco, 10A-hybrid Wrapper Tobacco, and Ilagan Sumatra Wrapper Tobacco. As found by De Vries and Sidenius (1916), according to Lava and Etorma, tobacco of superior quality is low in chlorine, ash (total percentage) and low in silica. As satisfying this condition, the varieties mentioned above may be selected.

SUMMARY

1. Proximate chemical analyses of the organic and inorganic constituents of sixteen tobacco varieties grown in the Philippines were made.

2. Nicotine was found to be low in Improved Gold Leaf College No. 7808 for the samples collected locally, White Stem Orinoco of the varieties which came from Alabang, Rizal and Gx-hybrid Wrapper Tobacco and Ax-hybrid Flue-cured for the varieties from Ilagan, Isabela.

3. No general tendencies were found to be noticeable in the differences obtained for figures on starch, water-soluble reducing sugars, ether extract or total nitrogen, except in Long Leaf Gooch Tobacco.

4. Silica was found to be low in variety Romero for the first four samples and in Jx-hybrid Wrapper Tobacco for samples which came from Ilagan, Isabela.

5. Iron, aluminum, sodium, and phosphorus were found to be variable within the groups of samples analyzed. No statement in the literature read was found as to the correlation of these constituents to tobacco qualities.

6. Calcium was found to be higher than magnesium in all tobacco samples analyzed and was also higher than the other inorganic constituents, excepting potassium and phosphorus in variety Ix-hybrid Wrapper Tobacco and potassium alone in 10B-hybrid Wrapper Tobacco. It was found to be high in Improved Gold Leaf College No. 7808 and Romero of the first four varieties and in White Stem Orinoco of the two varieties from Alabang, Rizal.

7. Magnesium was found to be low in Echague of the varieties collected locally, in White Stem Orinoco of the two varieties from Alabang, Rizal and in Ax-hybrid Flue-cured, Baker Sumatra Wrapper Tobacco and 10B-hybrid Wrapper Tobacco of the varieties from Ilagan, Isabela.

8. Potassium was found in all varieties to be higher than sodium and with the exception of calcium and silica it was also higher than the other constituents, except chlorine and phosphorus in Baker Sumatra Wrapper Tobacco and phosphorus in Ix-hybrid Wrapper Tobacco, and sulfur and chlorine in San Antonio.

9. Sulfur was widely variable in the materials collected locally but less so with the rest of the samples. The varieties low in this component were: Romero and Improved Gold Leaf College No. 7808 of the first group, White Stem Orinoco of the two samples from

Alabang, Rizal and Hx-hybrid Wrapper Tobacco, Ax-hybrid Flue-cured, Baker Sumatra Wrapper Tobacco, Ilagan Sumatra Wrapper Tobacco of samples that came from Ilagan, Isabela.

10. Chlorine was found to be more variable in samples which came from Ilagan, Isabela than in the other groups of samples analyzed. In the Ilagan groups, the following varieties were found to be low in chlorine: Ix-hybrid Wrapper Tobacco, Hx-hybrid Wrapper Tobacco, Gx-hybrid Wrapper Tobacco, Improved Gold Leaf College No. 7808, Baker Sumatra Wrapper Tobacco, and 10A-hybrid Wrapper Tobacco.

LITERATURE CITED

ANONYMOUS. 1930. Official and tentative methods of analysis. 3rd ed., xvii + 593 p. Washington, D. C.: American Association of Official Agricultural Chemists.

AMES, W. J., AND G. E. BLOTZ. 1915. Influence of fertilizers on composition and quality of tobacco. Ohio Agric. Exper. Sta. Bull. 285: 173–221.

BEHRENS, J. 1895. Weitere Beitrage zur Kentniss der Tabakpflanze. X Uber die Mittel zur Hebung der Qualitat des Tabaks. Landwirtsch Versuchs-Station XLVI Band. *Cited in* Lava, V. G. and S. B. Etorma. 1929. Comparative analyses of American and Philippine cigarettes. The Philippine Agriculturist **17**: 565–577.

GARNER, WIGHTMAN W. 1907. The relation of the composition of the leaf to the burning qualities of tobacco. U. S. Dept. Agric. Bur. Plant Indus. Bull. 105: 7–25.

GARNER, W. W. 1909. Principles and practional methods of curing tobacco. U. S. Dept. Agric. Bur. Plant Indus. Bull. 143: 7–54. *Fig. 1–10.*

GONZALEZ, JOAQUIN JORGE. The nicotine content of tobacco as affected by fertilizers. (Thesis presented for graduation from the College of Agriculture with the degree of Bachelor of Agriculture. 1919. Unpublished.)

GRAHAM, VERE, AND R. H. CARR. 1924. Chemical factors determining the quality of tobacco. Jour. Amer. Chem. Soc. **46**: 695–702.

LAVA, V. G., AND S. B. ETORMA. 1929. Comparative analyses of American and Philippine cigarettes. The Philippine Agriculturist **17**: 565–577.

MENDIOLA, NEMESIO B. 1922. Effect of different rates of transpiration on the dry weight and ash content of the tobacco plant. The Philippine Jour. Sci. **20**: 639–655.

SCHMUCK, A., AND BALABUHA-POPZOWA. 1927. The chemical characteristics of tobacco from some tobacco districts. State Institute for Tobacco Investigations, Krasnodar (Russia) Bull. 40: *Cited in* Lava, V. G., and S. B. Etorma. 1929. Comparative analyses of American and Philippine cigarettes. The Philippine Agriculturist **17**: 565–577.

SCHMUCK, A., AND V. SEMENOVA. 1927. Contents of carbohydrates and phenols in tobacco in relation to its color and quality. Central Institute for tobacco investigations. Krasnodar (Russia) Bull. 33: 1–20. *Cited in* Lava, V. G. and S. B. Etorma. 1929. Comparative analyses of American and Philippine cigarettes. The Philippine Agriculturist 17: 565–577.

VRIES, O. DE, AND E. SIDENIUS. 1916. Onderzoekingen over brandbaarheid van tabak. XXII Meddeelingen proefstation van tabak, Buitenzorg, Java. *Cited in* Lava, V. G. and S. B. Etorma. 1929. Comparative analyses of American and Philippine cigarettes. The Philippine Agriculturist 17: 565–577.

TABLE 1

Percentages of the organic constituents of tobacco computed on fresh basis

VARIETIES OF TOBACCO USED	SOURCE	MOISTURE	TOTAL ASH	CRUDE FIBER	NICOTINE	STARCH	WATER SOLUBLE REDUCING SUGARS	FATS OR ETHER EXTRACT	TOTAL NITROGEN
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
1. Echague	Caiñgin near College of Agriculture, U.P.	10.75	13.14	10.51	4.01	7.93	7.28	8.51	2.59
2. Improved Gold Leaf College No. 7808		12.17	15.03	9.32	1.39	7.94	2.97	7.21	2.37
3. Romero		10.56	13.32	8.97	3.25	7.95	2.79	9.87	3.52
4. San Antonio		9.90	17.30	10.52	2.82	6.38	3.06	7.26	3.04
5. Long Leaf Gooch Tobacco	Alabang, Rizal	19.42	10.75	11.47	2.67	12.08	10.86	6.11	2.78
6. White Stem Orinoco		23.01	12.84	4.38	1.02	6.64	1.36	7.46	2.34
7. Ax-hybrid Flue-cured	Ilagan, Isabela	19.65	12.63	9.33	1.51	6.52	1.84	6.29	1.99
8. Baker Sumatra Wrapper Tobacco		18.43	17.85	8.77	3.18	5.52	1.67	4.78	3.21
9. Gx-hybrid Wrapper Tobacco		18.16	16.58	9.17	1.15	5.18	2.46	8.84	2.77
10. Hx-hybrid Wrapper Tobacco		17.25	16.39	8.84	2.65	3.55	3.48	4.06	3.33
11. Ix-hybrid Wrapper Tobacco		18.11	16.71	15.05	2.24	6.41	1.94	5.87	2.89
12. Jx-hybrid Wrapper Tobacco		18.14	15.14	8.75	1.70	6.24	2.50	5.29	3.27
13. Ilagan Sumatra Wrapper Tobacco		20.24	14.54	9.59	1.67	6.27	2.44	5.73	3.01
14. 10A-hybrid Wrapper Tobacco		18.52	16.68	8.96	1.74	5.86	2.67	5.40	3.04
15. 10B-hybrid Wrapper Tobacco		19.73	15.72	10.85	2.38	4.59	2.31	6.70	2.74
16. Medium Fine Wrapper Tobacco	Amuling, N. Vizcaya	19.36	14.90	9.73	3.20	5.55	5.23	6.53	2.94

TABLE 2

Percentages of the organic constituents of tobacco computed on moisture-free basis

VARIETIES OF TOBACCO USED	SOURCE	TOTAL ASH	CRUDE FIBER	NICOTINE	STARCH	WATER SOLUBLE REDUCING SUGARS	FATS OR ETHER EXTRACT	TOTAL NITROGEN
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
1. Echague	Caiñgin near College of Agriculture, U. P.	14.72	11.78	4.49	8.89	8.16	9.54	2.90
2. Improved Gold Leaf College No. 7808		17.11	10.61	1.58	9.04	3.38	8.21	2.70
3. Romero	Alabang, Rizal	14.89	10.03	3.63	8.89	3.12	11.04	3.94
4. San Antonio		19.20	11.68	3.13	7.08	3.40	8.06	3.37
5. Long Leaf Gooch Tobacco		13.34	14.23	3.31	14.99	13.48	7.58	3.45
6. White Stem Orinoco		16.68	5.69	1.32	8.62	1.77	9.69	3.04
7. Ax-hybrid Flue-cured	Ilagan, Isabela	15.72	11.61	1.88	8.11	2.29	7.83	2.48
8. Baker Sumatra Wrapper Tobacco		21.88	10.75	3.90	6.77	2.05	5.86	3.94
9. Gx-hybrid Wrapper Tobacco		20.26	11.20	1.41	6.33	3.01	10.80	3.38
10. Hx-hybrid Wrapper Tobacco		20.05	10.68	3.20	4.29	4.21	4.91	4.02
11. Ix-hybrid Wrapper Tobacco		20.41	18.38	2.74	7.83	2.37	7.17	3.54
12. Jx-hybrid Wrapper Tobacco		18.49	10.69	2.08	7.62	3.05	6.46	3.99
13. Ilagan Sumatra Wrapper Tobacco		18.23	12.02	2.09	7.86	3.06	7.18	3.77
14. 10A-hybrid Wrapper Tobacco		20.47	11.00	2.14	7.19	3.28	6.63	3.73
15. 10B-hybrid Wrapper Tobacco		19.58	13.52	2.96	5.72	2.88	8.35	3.41
16. Medium Fine Wrapper Tobacco	Amuling, N. Vizcaya	18.48	12.07	3.97	6.88	6.49	8.10	3.65

TABLE 3

Composition of the ash of tobacco

VARIETIES USED	SOURCE	ASH IN DRY SUBSTANCE	INORGANIC CONSTITUENTS BASED ON THE ASH									
			Silica (SiO_2)	Iron oxide (Fe_2O_3)	Aluminium oxide (Al_2O_3)	Calcium oxide (CaO)	Magnesium oxide (MgO)	Sodium oxide (Na_2O)	Potassium oxide (K_2O)	Phosphoric acid anhydride (P_2O_5)	Sulfur (S)	Chlorides (Cl)
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
1. Echague	Caiñgin near College of Agriculture, U. P.	14.72	8.49	4.57	6.78	21.46	3.50	8.76	16.89	7.54	14.72	11.03
2. Improved Gold Leaf College No. 7808		17.11	10.58	6.84	1.66	35.93	7.45	2.98	13.84	9.18	4.99	8.16
3. Romero		14.89	4.20	4.05	6.98	35.96	6.61	5.78	11.49	10.74	2.70	11.01
4. San Antonio		19.20	15.26	3.82	10.98	15.95	6.13	7.50	9.25	5.42	10.98	10.05
5. Long Leaf Gooch Tobacco	Alabang, Rizal	13.34	13.67	8.93	3.28	31.53	7.07	3.64	13.02	10.97	7.81	10.02
6. White Stem Orinoco		16.68	10.98	4.13	3.50	35.98	3.24	3.60	17.52	9.35	5.22	10.91
7. Ax-hybrid Flue-cured	Ilagan, Isabela	15.72	15.84	10.85	4.28	19.95	3.16	5.22	18.05	5.06	4.20	17.05
8. Baker Sumatra Wrapper Tobacco		21.88	12.84	6.55	4.20	21.56	2.63	4.66	8.80	15.07	4.54	19.61
9. Gx-hybrid Wrapper Tobacco		20.26	11.51	6.76	5.67	25.99	7.53	2.47	14.35	6.75	6.61	7.47
10. Hx-hybrid Wrapper Tobacco		20.05	11.22	11.35	4.09	23.06	6.95	3.29	19.38	12.07	3.05	5.24
11. Ix-hybrid Wrapper Tobacco		20.41	10.24	5.63	5.27	14.90	6.88	2.99	23.40	19.70	4.61	5.10
12. Jx-hybrid Wrapper Tobacco		18.49	4.65	4.56	3.83	22.99	5.81	7.46	16.09	21.74	5.15	10.76
13. Ilagan Sumatra Wrapper Tobacco		18.23	17.00	6.81	5.36	18.91	5.98	7.02	16.30	11.03	5.09	9.54
14. 10A-hybrid Wrapper Tobacco		20.47	10.45	8.33	2.28	20.14	5.76	5.66	17.98	8.79	9.35	8.99
15. 10B-hybrid Wrapper Tobacco		19.58	9.50	9.05	1.02	17.68	3.88	2.76	22.88	4.71	6.87	10.25
16. Medium Fine Wrapper Tobacco	Amuling, N. Vizcaya	18.48	10.88	4.97	7.18	23.09	7.38	1.95	19.36	8.05	4.23	13.42

THE RELATIVE VALUE OF TAHUP SA MAIS AND RICE BRAN IN RATIONS FOR EGG PRODUCTION [1]

CESAR J. FERNANDEZ

In Cebu, *tahup sa mais* is a by-product obtained from corn in the preparation of *bugas mais* (literally translated "rice of corn") for human food. According to some corn mill owners in Cebu, in the preparation of *bugas mais* from corn kernels, approximately 30 per cent tahup by volume, or 17 per cent by weight, is obtained. According to the *Statistical Bulletin of the Philippine Islands* for the year 1928, the total production of corn in Cebu alone was 2,436,990 cavans of shelled corn.[2] Obviously, a large amount of tahup is produced in Cebu alone every year, where the average price is ₱0.80 a cavan, or ₱0.024 a kilogram.

In Cebu, tahup sa mais is commonly fed to chickens, hogs, horses, carabaos and cattle. It would seem that some knowledge of the feeding value of this by-product should be highly interesting to animal husbandmen. As it is a common product in the corn producing provinces, poultrymen should be interested to know to what extent tahup may be fed to chickens. Possibly it may be used as a substitute for, or in combination with, rice bran. In either case, a wider market for tahup will be opened. For these reasons the results obtained from this study should be very helpful and timely.

REVIEW OF LITERATURE

No studies on tahup were found in the available literature. However, it is a well known fact that corn meal is the foundation of most poultry mashes in this country. The same is true in the United States (Henry and Morrison, 1929).

According to Jull (1930), in vitamin A content yellow corn is better than white corn. Steenbock and Boutwell (1919) in a study on the comparative nutritive value of white and yellow maize concluded that yellow maize contains enough of the fat-soluble vitamin to allow growth at a normal rate to take place in the rat; reproduction was possible but usually was a failure; but that white maize

[1] Thesis presented for graduation, 1934, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 427; Experiment Station contribution No. 981. Prepared in the Department of Animal Husbandry under the direction of Dr. F. M. Fronda.

[2] One cavan of shelled corn weighs 58.5 kilograms.

does not contain any demonstrable amount of the fat-soluble vitamin. In attempts to have it serve as the source of fat-soluble vitamin, rats seldom remained alive longer than three months. Mussehl, *et al*, (1921), as cited by Jull (1930), claimed that yellow corn is deficient in ash and in the quality and quantity of proteins for the maintenance of normal growth of chicks.

Johns, Finks and Paul (1920) cited Osborne and Mendel as reporting that corn contains the following proteins:

	Per cent protein
Globulins + albumins + "proteoses"	21.9
Zein	41.4
Maize glutelin	30.8
Insoluble in alkali	5.9
	100.0

These authors considered that corn proteins of sufficient concentration in the diet are adequate for normal growth. They further concluded that 18 per cent of corn meal furnished an adequate supply of water-soluble vitamin. In human nutrition it was shown by Sherman, Wheeler and Yates (1918) that corn meal to supply 31 per cent of the total protein in a low protein diet was efficiently used in the maintenance of the nitrogen equilibrium.

Robertson (1918) claimed that whole corn while providing the fowl a full meal does not give sufficient exercise. He advises the use of cracked corn, scattered in the litter, so that the hen will work to get it. Maynard, Fronda and Chen (1923) reported that the proteins of corn meal and rice bran mutually supplement each other; and also that the proteins of rice bran are better than those from corn meal.

OBJECTS, PLACE AND TIME OF THE EXPERIMENT

The objects of the experiment were: (*a*) to compare the relative feeding value of tahup and rice bran supplemented with copra meal and fish meal in rations for laying hens, and (*b*) to determine the effects of the combination of tahup and rice bran supplemented with copra meal and fish meal for the same purpose.

This experiment was conducted in the Department of Animal Husbandry of the College of Agriculture from September 1, 1932 to August 31, 1933.

MATERIALS AND METHODS

Lots and feed for each lot

The birds. In this study, 90 Los Baños Cantonese pullets that were just starting to lay were used. These pullets were divided into three lots of 30 birds each, with one cockerel to each lot. The lots were housed in pens similar in size and construction; adjoining each pen were two grassy yards which were used in rotation.

Rations used. The rations used consisted of one part of grain and one part of mash. The grain mixture was composed of equal parts of cracked corn and palay. The mash mixtures consisted of the following:

INGREDIENTS	LOT 1	LOT 2	LOT 3
Tahup sa mais	6	—	3
Rice bran (fine)	—	6	3
Copra meal	2	2	2
Fish meal	2	2	2
Total	10	10	10

Nature of feed under study. Tahup is a by-product obtained by winnowing the ground corn (corn meal) in a shallow egg-shaped basket called *nego,* particularly designed for this purpose. The tahup consists of the corn germ, the hull, the tip cap, and portions of endosperm.

Analysis of the feeds used. Table 1 gives the chemical analysis of tahup, corn meal (for comparison), and rice bran as determined by the Department of Agricultural Chemistry, College of Agriculture. In this table it will be seen that rice bran contains more proteins than tahup, which is itself richer than corn meal. Rice bran also exceeds both corn meal and tahup in the fat and ash contents, but tahup exceeds corn meal. Corn meal has the least amount of crude fiber, and rice bran has the most. In carbohydrate content tahup is higher than rice barn. In calorific value, corn meal gives more than either tahup or rice bran.

Feeding, care and management

The mash was fed dry in open mash hoppers to which the birds had free access during the day. They were also given wet mash about noon. Grain (equal parts of palay and cracked corn) was fed regularly, morning and afternoon. In order to determine the

individual egg production, trap nests were used. Broody hens were confined in the broody croops till their broodiness was broken. So far as possible the three lots were given the same care and attention.

Records

The total egg production for each month and for the year was carefully determined and recorded. The initial weights of the birds were taken and recorded as were the monthly weights for twelve months. Mortality records were kept. The fertility and hatchability of the eggs produced from each lot were determined. Other pertinent observations, though of minor importance, were also made and recorded.

RESULTS AND DISCUSSION OF RESULTS

Monthly weights of pullets. The monthly weights of the birds from the beginning to the close of the experiment are given in table 2. By reference to this table, it may be noted that the increase in weight of the birds in the tahup lot (lot 1) and rice bran lot (lot 2) were almost the same, but the lot that was given a combination of tahup and rice bran (lot 3) hardly gained at all. Expressing in percentages the gains in weight made by the different lots the birds in the tahup lot gained 7.56 per cent; those in the rice bran lot, 7.96 per cent; while the tahup-rice bran lot made only 0.104 per cent gain. Cruz (1918) in a study on the effects of single and mixed feeds reported that palay-fed chicks gained more than those fed with corn, while a mixture of the two gave better results than either of them fed singly. Chan and Guiyab (1934) in a study on corn versus palay as feed for growing chickens using shrimps as supplement, found that corn-fed chickens grew faster and gained more and with lower mortality, than the palay-fed chickens.

It will be seen also in table 2 that the three lots increased in weight until November when the birds in the tahup lot (lot 1) abruptly decreased and fluctuated the rest of the year. The birds in the rice bran lot (lot 2) maintained their weight. The birds in the tahup-rice bran lot (lot 3) gradually decreased in weight till the end of the experiment.

Egg production. The percentages of monthly egg production are given in table 3. By reference to this table, it may be seen that each lot had three months of high egg production. For the tahup lot (lot 1), October, January and March were the high producing months; for the rice bran lot (lot 2), October, January, March, April and June; and for the tahup-rice bran lot (lot 3), October, January and March which was continued until May.

The actual number of eggs laid by the different lots are shown in table 4. The tahup-rice bran lot (lot 3) produced the largest number of eggs, the tahup (lot 1) was next, and the rice bran lot (lot 2) was the lowest. The average yearly production of eggs per hen in the tahup lot (lot 1) was 88.29; the rice bran lot (lot 2), 81.76; the tahup-rice bran lot (lot 3) with 95.97 eggs was the highest. It may be seen further in table 3 that lots 1 and 3 produced eggs of about the same average weight, while lot 2 produced slightly smaller eggs. However, studies made in the Arkansas Agricultural Experiment Station (Anonymous, 1927) showed that hens receiving the greatest amount of rice by-products produced the heaviest eggs, but the fewest in number. In the Louisiana Agricultural Experiment Station (Anonymous, 1930), it was found that laying hens given from 10 to 30 per cent rice products in the ration produced as well, and in some cases better, than hens receiving no rice products. Chan and Guiyab (1934), reported slightly higher production with palay than with corn, but the corn produced slightly heavier eggs than the palay.

If, however, only the egg production of the birds that survived the experiment were considered, the egg production percentages for each pen would be slightly increased. The tahup-rice bran lot (lot 3) would have 28.10 per cent; the tahup lot (lot 1), 25.43 per cent; and the rice bran lot (lot 2), 24.33 per cent, the lowest. The average egg production per hen would be 92.85 eggs in lot 1, 88.83 eggs in lot 2 and 102.59 eggs in lot 3.

It would seem that for egg production a combination of tahup and rice bran would be better than either of the two when fed alone. Rice bran fed birds had a tendency to produce eggs of small size, though the difference in size in the three lots was insignificant.

Feed consumption. The amounts of feed consumed by the birds, may be seen also in table 4. The tahup lot (lot 1) actually consumed more feed than the rice bran lot (lot 2). This was because lot 1 had more birds than lot 2. When the average per bird was determined, it was found that those in lots 1 and 2 consumed approximately the same amount of feed, but those in the tahup-rice bran lot (lot 3) consumed a little more than the birds in either lot 1 or lot 2.

These results are considerably lower than those obtained in the First (1930-1931) and Second (1931-1932) Philippine Egg Laying Contests. It was reported that in these contests, the Los Baños Cantonese consumed the smallest amount of feed, which was 27.44 kgm. a bird in the first contest, and 30.24 kgm. in the second. In another

study, Fronda (1932) reported an average of 28.14 kgm. of feed per bird per year for the Los Baños Cantonese.

From the results obtained in the present study, it is apparent that a combination of tahup and rice bran is a little better relished than either of the two feeds when given alone. Tahup was observed to be a little more palatable than rice bran. Tuason and Fronda (1934), using rough rice, or palay and corn, reported palay to be more palatable than corn. In the present experiment the rations used in the three lots may have been very much less palatable than the feed mixture used by Fronda in the First (1930-1931) and the Second (1931–1932) Philippine Egg Laying Contests.

Relative cost of eggs in the three lots. In the computation of the cost of feeds consumed by the birds, the Department of Animal Husbandry prices at the time of experiment were used. These were as follows:

Feeds	*Average cost per kgm. of feeds*
Corn	₱ 0.050
Palay	0.042
Rice bran	0.035
Tahup sa mais	0.049
Fish meal	0.139
Copra meal	0.028

In table 5 is shown the relative cost of the feeds consumed and of the eggs produced. It may be noted that the tahup lot consumed ₱34.84 worth of feeds and produced a value of ₱68.76 in eggs, thus giving a return of ₱33.92 above the cost of feeds. The rice bran lot produced ₱59.04 worth of eggs while it consumed ₱29.67 worth of feeds, giving a return of ₱29.37 above the cost of feeds. The tahup-rice bran lot produced ₱77.85 worth of eggs and consumed ₱36.39 worth of feed, thus giving a return of ₱41.46 above the cost of feeds. The selling price of the eggs was ₱0.36 per dozen.

The cost of producing one dozen eggs in the tahup and the rice bran lots (lots 1 and 2) was practically the same, because the price per kilogram of feed in the tahup lot (lot 1) was higher than in the rice bran lot (lot 2) but the amount needed was greater in the latter than in the former. The tahup-rice bran lot (lot 3), however, produced eggs the most economically. Fronda (1932) reported that the total cost of producing one dozen eggs from the best of the seven mashes that he studied was ₱0.186. The ration consisted of one part shrimp meal, two parts corn meal, three parts copra meal, and four parts rice bran. In this study, if the feed cost is 60 per cent of the

total cost of production (Fronda and Paje, 1930), the best ration of the three lots was the tahup-rice bran lot (lot 3) which produced one dozen eggs at a cost of only ₱0.280. The cost of production, however, would have been much lower for the tahup lot (lot 1) had the cost of tahup been as low as in Cebu.

From the same table (table 5), it may be seen that the tahup-rice bran lot (lot 3) gave a net gain from one dozen eggs of ₱0.08 which was the highest; the rice bran lot (lot 2) was next with ₱0.057, and the tahup lot (lot 1) lowest with ₱0.055. These gains naturally follow from the fact that the tahup-rice bran lot (lot 3) consumed feed to the value of only ₱0.168 for one dozen eggs, while in the rice bran lot (lot 2) it was 0.182, and in the tahup lot (lot 1), ₱0.183. Considering the tahup-rice bran lot as 100 per cent efficient, and basing calculations on the values given above, the tahup lot was only 68.75 per cent, and the rice bran lot was only 71.25 per cent as efficient as the tahup-rice bran lot in point of gain from one dozen eggs.

Mortality of the hens. In table 6 is given the mortality distribution of the birds in the three lots. It will be observed that the highest percentage of mortality among the three lots occurred from March to July. During these months the days were very hot and the nights cool. This unfavorable condition may have made the birds weak and easily victims of pneumonia as the post mortem examinations made in the Veterinary College showed this disease the cause of each death. Also, another factor that may have contributed to the high mortality was the presence of a pernicious and persistent disease of the vent, vent gleet.

Other things being equal, the rice bran lot (lot 2) had the highest mortality, followed by the tahup lot (lot 1), with the tahup-rice bran lot (lot 3) the lowest. There was 40 per cent mortality in the tahup lot (lot 1), 50 per cent in the rice bran lot (lot 2), and 23.33 per cent, in the tahup-rice bran lot (lot 3).

Fertility and hatchability of the eggs. An equal number of eggs was saved for incubation from each of the three lots from June 23 to August 26, 1933. The eggs were set every seven days; there were eight settings made. The results presented in table 7 is a summary of these eight settings.

It was observed that in all the trials made, the eggs from the tahup lot were consistently lower in fertility than the eggs produced from the rice bran lot. The tahup-rice bran lot, on the other hand, had a most variable fertility. On an average it was found that the eggs produced in the tahup lot (lot 1) had a fertility of 73.03 per

cent; those from the rice bran lot (lot 2), 87.07 per cent; and those from the tahup-rice bran lot (lot 3), 79.77 per cent.

The percentage of dead embryos (in the first, second and third weeks of incubation) was highest in the tahup lot, being 37.05 per cent. The tahup-rice bran lot was next with 31.44 per cent; the rice bran lot with only 29.21 per cent was lowest. As might be expected the rice bran lot had the highest percentage of hatch, 57.86 per cent; the tahup-rice bran lot (lot 3) next with 48.31 per cent; and tahup (lot 1) lowest with 35.95 per cent.

From these results it appears that rice bran is very much better than tahup to use in rations for breeding hens. It not only produced fewer infertile eggs, but also lower embryonic mortality and hence larger hatch. The combination mixture of tahup and rice bran did not give as good results as rice bran, but they were better than the tahup lot.

Minor observations. It was observed that the hens from the tahup-rice bran lot appeared livelier than those of either of the other two lots; the hens in the rice bran lot appeared listless, and those of the tahup lot were intermediate. The combination lot had the most broody hens, followed by the rice bran lot. It was also observed that no soft-shelled eggs were laid in the rice bran lot or combination lot, while five were laid in the tahup lot. The yolk of the eggs from the rice bran and tahup lots were about the same in intensity of yellow, while the combination lot had egg yolk of darker yellow. In flavor, however, there was no marked difference in the eggs of the three lots. Alcasid (1918) reported that rice fed ducks laid eggs tasting somewhat putrid.

In the last part of the present experiment it was noted that the manure in the tahup lot had a large amount of undigested materials which were distinguished to be broken hulls of the cracked corn. The birds in the rice bran lot produced a sticky dark brown manure; the combination lot a dark brown, quite loosely constituted fine manure.

SUMMARY OF RESULTS

The results of a study on the relative value of tahup and rice bran in rations for egg production are reported and discussed in this paper. From the results obtained, the following summary may be drawn:

1. The birds that were fed tahup (lot 1) had about the same average percentage of egg production as those in the rice bran lot (lot 2). The birds in the tahup-rice bran lot (lot 3) had the highest percentage of egg production.

2. There was no appreciable difference in the weight of the eggs produced in the three lots.

3. The average feed consumption a year per bird was 24.76 kgm. in the rice bran lot; 24.92 kgm. in the tahup lot; and 25.88 kgm. in the tahup-rice bran lot.

4. The cost of feeds required to produce one dozen eggs was ₱0.183 in the tahup lot, ₱0.182 in the rice bran lot; and ₱0.168 in the tahup-rice bran lot.

5. There was no appreciable difference in the increase in weight of the birds in the tahup and rice bran lots; in the tahup-rice bran lot, however, there was hardly any increase.

6. Mortality was highest in the rice bran fed lot, and lowest in the tahup-rice bran lot.

7. The tahup fed lot had the highest percentage of infertile eggs; followed by the tahup-rice bran lot; and the rice bran fed lot had the lowest.

8. The percentage of hatch was highest among the eggs produced in the rice bran fed lot, followed by those in the tahup-rice bran fed lot; and the tahup fed lot was the lowest.

9. The egg yolk color of the tahup-rice bran fed lot was a deeper yellow than that of either the tahup or rice bran fed lots.

10. Tahup sa mais and rice bran have about the same feeding value for egg production, but the combination of the two is better than either alone. The choice in their use should be determined largely by their local market price.

REFERENCES

ANONYMOUS. 1928. Philippine Bureau of Commerce and Industry Statistical Bulletin 11: p. 48.

ANONYMOUS. 1930. Experiment with poultry. Louisiana Sta. Bien. Rept. 1928–1929. 47–49 pp. *Cited in* the U. S. Dept. Agric. Exper. Sta. Rec. **63**: 364–365. 1930.

ALCASID, EXEQUIEL E. 1919. The growth and egg production of ducks as affected by feeding rice and corn. The Philippine Agriculturist **7**: 255–266.

CHAN, GREGORIO S., AND J. D. GUIYAB. 1934. Comparative studies of the value of corn and palay as feed for chickens. The Philippine Agriculturist **23**: 49–72.

CRUZ, FLORENTINO F. 1918. The effect of certain feeds on growth and production of eggs and meat by poultry. The Philippine Agriculturist and Forester **7**: 44–54.

FRONDA, F. M. 1932. Comparative studies on the values of different mash mixtures for egg production. The Philippine Agriculturist **21**: 96–105.

Chart 1.

FRONDA, F. M. 1932. A study of the results of the First Philippine Egg Laying Contest. The Philippine Agriculturist 20: 596–603.

FRONDA, F. M. 1933. A study of the results of the Second Philippine Egg Layin Contest. The Philippine Agriculturist 22: 148–156.

FRONDA, F. M., AND PEDRO S. PAJE. 1930. Factors in the cost of egg production. The Philippine Agriculturist 19: 337–353. *Charts 1–4.*

HENRY, W. A., AND F. B. MORRISON. 1929. Feeds and feeding. Abridged. 6th ed. viii + 440 pp., 114 fig. Milwaukee: C. N. Caspar Company.

JOHNS, CARL O., A. J. FINKS, AND MABEL S. PAUL. 1920. Studies in nutrition. III. The nutritive value of commercial corn gluten meal. Jour. Biol. Chem. 41: 391–399. *Charts 1–4.*

JULL, MORLEY A. 1930. Poultry husbandry. ix + 639 p., 229 fig. New York: McGraw-Hill Book Company, Inc.

MAYNARD, L. A., F. M. FRONDA, AND T. C. CHEN. 1923. The protein efficiency of combinations of corn meal and certain other feeding stuffs, notably rice bran. Jour. Biol. Chem. 55: 145–155.

MUSSEHL, F. E., J. W. CALVIN, D. L. HALBERSLEBENN AND R. M. SANDSTEDT. 1921. Nutrient requirements of growing chicks: nutritive deficiencies of corn. Journal Agricultural Research 22: 139–149. *Cited in* Jull, Morley A. 1930. Poultry Husbandry. *Supra.*

ROBERTSON, GEORGE. 1918. Poultry feeds and feeding. Dominion of Canada, Dept. Agric. Bull. 91: 1–31. *Fig. 1–12.*

SHERMAN, F. C., LUCILE WHEELER, AND ANNA B. YATES. 1918. Experiments on the nutritive value of maize protein and on the phosphorous and calcium requirements of healthy women. Jour. Biol. Chem. 34: 383–393.

STEENBOCK, H., AND P. W. BOUTWELL. 1919. Fat-soluble vitamine. III. The comparative nutritive value of white and yellow maize. Jour. Biol. Chem. 41: 81–96. *Pl. 1–2; charts 1–7.*

TUASON, NICASIO A., AND F. M. FRONDA. 1924. Studies on Philippine poultry feeds: I. Availability and palatability. The Philippine Agriculturist 12: 459–464.

TABLE 1

Showing the chemical composition of tahup sa mais, corn meal and rice bran

	CORN MEAL	TAHUP SA MAIS	RICE BRAN (FINE)
	per cent	*per cent*	*per cent*
Moisture	12.84	10.67	9.20
Fats (ether extract)	4.91	4.95	13.89
Ash	1.30	3.25	10.11
Protein (N × 6.25)	9.37	9.69	12.38
Crude fibers	1.81	5.39	9.72
Carbohydrates (N. F. E.)	69.77	66.05	44.70
Calories per 100 grams	370.14	357.00	363.21

TABLE 2

Showing the monthly average weights of the birds

MONTHS	LOT 1 (TAHUP LOT)	LOT 2 (RICE BRAN LOT)	LOT 3 (TAHUP-RICE BRAN LOT)
	grams	*grams*	*grams*
Initial	1226.4	1197.8	1264.9
September	1301.8	1254.6	1267.1
October	1336.9	1315.7	1370.6
November	1240.7	1357.3	1366.0
December	1330.0	1322.7	1346.7
January	1330.3	1330.3	1335.3
February	1301.4	1342.1	1328.7
March	1245.8	1385.8	1316.3
April	1263.2	1369.5	1298.4
May	1266.1	1303.5	1301.7
June	1257.1	1265.0	1317.4
July	1273.3	1306.7	1292.2
August	1326.7	1301.3	1278.3
Net gain [a]	100.2	103.6	13.3
Percentage gain	7.56	7.96	0.103

[a] The net gain was obtained by subtracting the initial weights of the pullets from their final or August weights.

TABLE 3

Showing monthly percentage of egg production

MONTHS	LOT 1 (TAHUP LOT)	LOT 2 (RICE BRAN LOT)	LOT 3 (TAHUP-RICE BRAN LOT)
	per cent	*per cent*	*per cent*
September	25.00	21.33	19.55
October	32.36	24.30	24.62
November	25.14	17.44	21.44
December	20.02	16.66	19.13
January	24.69	23.70	28.81
February	20.44	22.04	25.59
March	30.31	27.18	31.85
April	25.19	29.37	31.85
May	21.85	24.41	31.80
June	20.56	25.00	28.86
July	19.79	21.36	25.80
August	20.78	16.77	23.70
Av. egg production	23.84	22.44	26.08

TABLE 4

Showing number of eggs laid, egg weights and feed consumption

	LOT 1 (TAHUP LOT)	LOT 2 (RICE BRAN LOT)	LOT 3 (TAHUP-RICE BRAN LOT)
Total eggs laid	2292	1968	2595
Average egg weight, in grams [a]	36.48	35.68	36.63
Average yearly production per hen	88.29	81.76	95.97
Total grain consumed, in kgm.	345.5	330.0	367.1
Total mash consumed, in kgm.	301.6	266.3	332.8
Average grain consumed per hen in the year, in kgm.	13.30	13.70	13.57
Average mash consumed per hen in the year, in kgm.	11.62	11.06	12.31
Average feed consumption per hen in the year, in kgm.	24.92	24.76	25.88

[a] Number of eggs weighed, 188.

TABLE 5

Showing the relative cost of feeds used and eggs produced

	LOT 1 (TAHUP LOT)	LOT 2 (RICE BRAN LOT)	LOT 3 (TAHUP-RICE BRAN LOT)
	pesos	*pesos*	*pesos*
Total value of eggs produced at 3¢	68.76	59.04	77.85
Total value of feeds consumed	34.84	29.67	36.39
Returns above cost of feeds	33.92	29.37	41.46
Value of eggs produced per hen at 3¢	2.65	2.46	2.88
Value of feeds consumed per hen .	1.35 [a]	1.21 [b]	1.35 [c]
Returns of eggs produced above cost of feed per hen	1.30	1.25	1.53
Amount of feeds to produce one dozen eggs, in kgm.	3.39	3.64	3.24
Feed cost of producing one dozen eggs	0.183	0.182	0.168
Total cost of producing one dozen eggs [d]	0.305	0.303	0.280
Net gain from one dozen eggs	0.055	0.057	0.080
Efficiency of feeds in per cent ...	68.75	71.25	100.00

[a] Cost of grain per kgm. ₱0.0460.
Cost of mash per kgm. ₱0.0628.
[b] Grain at ₱0.0460 per kgm.
Mash at ₱0.0544 per kgm.
[c] Grain at ₱0.0460 per kgm.
Mash at ₱0.0586 per kgm.
[d] If feed cost is 60 per cent of total cost of production.

TABLE 6

Showing monthly mortality percentage

MONTHS	LOT 1 (TAHUP LOT)	LOT 2 (RICE BRAN LOT)	LOT 3 (TAHUP-RICE BRAN LOT)
	per cent	*per cent*	*per cent*
September	—	—	—
October	—	—	—
November	3.33	—	—
December	—	—	—
January	—	3.33	—
February	—	—	—
March	10.00	20.00	10.00
April	3.33	13.33	6.66
May	6.66	6.66	3.33
June	6.66	3.33	3.33
July	10.00	3.33	—
August	—	—	—
Total	40.00	50.00	23.33

TABLE 7

Showing the fertility and hatchability of eggs in percentages[a]

	LOT 1 (TAHUP LOT)	LOT 2 (RICE BRAN LOT)	LOT 3 (TAHUP-RICE BRAN LOT)
Number of eggs incubated	178	178	178
Percentage of infertile eggs[b]	26.97	12.93	20.23
Percentage of D_1[c]	11.79	9.55	10.11
Percentage of D_2[d]	7.85	10.11	8.98
Percentage of D_3[e]	17.41	9.55	12.35
Percentage of P[f]	1.12	1.67	0.0
Percentage of hatch	35.95	57.86	48.31

[a] All percentages were based on total number of eggs set.
[b] Only the apparent infertility was considered.
[c] Germ that died in the first week of incubation.
[d] Germ that died in the second week of incubation.
[e] Eggs that did not hatch.
[f] Eggs pipped but did not hatch.

A TEST OF SOME GREEN MANURE CROPS [1]

CELESTINO S. ALONSO

INTRODUCTION

Green manures are especially useful as soil renovators, and as such their value depends upon the quantity of plant food materials they add to the soil when they are turned under. Their value depends also upon the physical and biological effects that they may bring about in the soil during their different stages of growth and development.

Green manuring, when legumes are used, add nitrogen both directly and indirectly to the soil. They add nitrogen directly by the activity of the nodule bacteria on their roots which absorb free nitrogen from the air using carbon in the organic matter of the plant as a source of energy and changing it into a form that the plant can use. Leguminous green manures add nitrogen indirectly when the green manures are turned under, as the nitrogen they contain is added to the soil. The quantity of dry matter obtained from a green manure crop is an index of humus supply. Humus is the principal source of nitrogen in the soil. It also retains moisture in the soil and prevents surface evaporation. A surface soil fairly rich in humus exercises much the same influence on the underlying soil as does a mulch of dead leaves or other vegetable matter. The presence of humus in the soil also tends to improve the soil texture making it light and loose, hence preventing compaction of the surface. Because of this quality it is of special value in the amelioration of stiff soils. The quantity of P_2O_5 contained in the root system, whether deep or shallow, and the ease of incorporating the plants are essential qualities considered in valuing a green manure crop.

Although these beneficial effects derived from green manure crops are recognized in all scientific agriculture, very little study on this subject has been made in the Philippines.

A survey of the literature on the subject indicates that work in other countries has been only of a general nature. The effect of

[1] Thesis presented for graduation, 1932, with the degree of Bachelor of Agriculture from the College of Agriculture, No. 428; Experiment Station contribution No. 982. Prepared in the Department of Agronomy under the direction of Mr. Vicente B. Aragon.

green manures on the soil has been studied, and incidentally, in these studies it was found that the young green manures decompose more rapidly than the old. Not much attention seems to have been given to finding out the period when the plant used as green manure would yield the best result.

Johnson, Thompson and Sahr (1918) found that of 32 varieties of legumes, including six varieties of cowpea and four of velvet beans, Sunn-hemp (*Crotalaria juncea*) and wild "rattlepods" (*Crotalaria* spp.) appeared to possess the highest nitrogen adding efficiencies. They were therefore recommended as green manures in Hawaii. These investigators also found that all the green manures they used matured within three to six months, and that the dry matter content of the different legumes used increased as the plants advanced towards maturity.

Koch (1924) in his study on the value of green manure crops stated that plants with woody branches and stems yielded a percentage of water free matter that is much higher than in leafy crops. Quick growers like *Crotalaria usaramoensis* Bak. f. and *Crotalaria anagyroides*, HBK, as well as slow growers like *Indigofera sumatrana* Jacq., show sometimes a high content of nitrogen. A great deal of phosphorus was found at the age of four to five months in *Crotalaria usaramoensis* Bak., *Crotalaria anagyroides*, HBK, *Cassia mimosoides* Linn. and *Indigofera hirsuta Linn.* Koch stated further that the quantity of phosphate compared with the quantity of nitrogen differs also with the plant.

The objects of the study on green manures reported in this paper were, (*a*) to study the comparative values of nine green manure crops in the Philippines; (*b*) to determine the quantity of dry matter they produce; and (*c*) to analyze them for the values of N_2 and P_2O_5 in the different stages of growth and development under field conditions.

The work was begun in April, 1931 and closed in February, 1932. The lots used are located in the Experiment Station grounds of the College of Agriculture, and are under the care of the Farm Crop Division of the Agronomy Department.

MATERIALS AND METHOD

Plants used

Nine species of green manure crops were used in this study. They were *Tephrosia candida* (Roxb.) DC., *Tephrosia noctiflora* Boj., *Crotalaria juncea* Linn., *Crotalaria usaramoensis* Bak. f., *Indigofera hendecaphylla* Jacq., *Crotalaria anagyroides* HBK, *Phaseolus*

aureus Roxb., *Vigna sinensis* (Linn.) Savi, and *Calopogonium muconoides* Desv. Seeds and cuttings were taken from the stock of the Department of Agronomy, College of Agriculture.

So far as the writer knows, seven of the green manure crops used in this study were imported from Java into the College of Agriculture through seeds secured by Dr. Nemesio B. Mendiola, Head of the Agronomy Department. *Vigna sinensis and Phaseolus aureus* were brought to the College from neighboring provinces. All these green manure plants grow well in the clay loam soil of the College Experiment Station.

Planting and cultivation

The field was plowed and harrowed two times in April, 1931 and a third time after the first rain in May of the same year. The fourth plowing followed by the making of furrows 1.2 meters apart was one week later. The field was then divided into nine lots, 15 by 10 meters, one lot being assigned to each of the nine different green manures. Each of these lots was divided into three equal plots each containing eight furrows. On the morning of May 28, seeds of eight of the nine species used were sown in the furrows in hills 20 cm. apart, three to four seeds a hill. The sower covered the seeds at once with soil with his feet. Cuttings about 30 cm. long were used in planting *Indigofera hendecaphylla* Jacq. Three to four cuttings were planted to a hill; the hills were 20 cm. apart in the row. The cuttings were planted in a slanting position with about 10 cm. exposed on the surface of the ground. The planting of all crops was completed within three days.

By hoeing between the rows as soon as was necessary, weeds were controlled so they did not grow taller than the green manure plants. All the plants were treated the same way as nearly as possible.

Age of the plants when materials for analysis were gathered and turned under

Except the cowpea (*Vigna sinensis*) and mungo (*Phaseolus aureus*), each of the green manures was studied at six different stages of growth. Material was gathered at the ages of two months, two and one-half months, three and one-half months, four months, five months and six months. Mungo (*Phaseolus aureus*) and cowpea (*Vigna sinensis*) were studied in only three stages; namely, at the age of one month, two months, and two and one-half months. Samples for analysis were taken at each of these stages. At the same time,

representative samples from each plant were dug up and were buried 30 cm. deep in the row. There were 9 replications for each green manure for one stage. Pegs were placed to locate buried green manure and were tagged with a wooden label bearing the date of turning under. Two observations were made two weeks apart to study the behavior of the green manures to note whether or not they die soon after they are turned under. And incidentally to study the decomposing green manures in the soil.

Analysis of the plants

The plants in one square meter from each of the replications of the different green manure crops were dug up and the roots were carefully washed. The fresh weight of these plants from each plot was recorded for each crop in all the stages studied. Ten representative plants from each plot of the different lots of green manures were studied carefully. The length of the stem and of the taproot was measured and the condition of the plants was recorded. Then 10 representative plants were taken from these 30 plants and chopped fine with a sharp bolo on a piece of hard wood. This chopped material was thoroughly mixed and sampled and a convenient amount was weighed on a Cenco balance to obtain the fresh weight. These samples were dried in winnowing baskets in the sun on a cement floor to get the sun-dried matter. Drying was continued until the weight was constant; then the quantity of sundried matter was calculated.

These sun-dried samples were placed in mason jars made airtight and properly labelled. The jars were then sent to the Chemistry Experiment Station Laboratory for analysis of oven-dry matter for N_2 and P_2O_5.

RESULTS

There was a good percentage of germination of all the plants and the stand of the young seedlings was fairly uniform.

The results of the study are presented in tables 1 to 5. Table 1 shows the date of sowing and flowering, the number of days it took the green manures to flower and the time necessary for them to mature.

Table 2 shows the average measurements of taproots and stems of the different green manures and their respective yield of fresh matter in kilograms per square meter at various stakes. These measurements were the average of 10 representative plants from one in three replications for each green manure crop.

Table 3 gives the results of turning under green manures at various stages to a depth of 30 cm. and examination at 14 days interval for a period of one month.

Table 4 shows the results of the analyses of the green manures (whole plant) gathered at various stages. The percentages of composition of N_2 and P_2O_5 were based on constant weight obtained by drying at 100-50°C. and the water-free product was calculated on the basis of fresh matter.

Table 5 shows the comparative values of the nine green manuring plants. The added efficiencies of fertilizing materials (N_2, P_2O_5, and free matter product) were calculated on the average production of fresh matter in kilogram per square meter of each kind of the green manure crops.

DISCUSSION OF RESULTS

According to results given in table 1, the different green manure crops may be classified into quick and slow maturing. This classification is important as a guide in selecting green manure crops to suit the time available for green manuring. If only 4 to 7 months are available for green manuring, *Phaseolus aureus, Vigna sinensis, Crotalaria usaramoensis, Crotalaria anagyroides* and *Tephrosia noctiflora* are among the best. *Tephrosia candida, Crotalaria juncea, Indigofera hendecaphylla* and *Calopogonium muconoides* are better suited for longer periods. *Crotalaria juncea* may be used for periods intermediate between the two groups.

Table 2 shows the comparative lengths of stems and roots (taproot) of the different plants used at various stages. The probable errors of the averages of the stems and roots were calculated to show the index of variability. The greater the index, the greater is the variability of the character studied, and *vice versa.* The greatest variability was found on the measurements of the stems of *Calopogonium muconoides.* This plant is a creeping vine, the stems of which intertwine in all directions and form a thick cover on the ground. It was almost impossible to get a representative plant without breaking some of the stems. This condition brought about a greater index of variability than with the erect plants.

The depth of the root is an important point to consider in selecting plants for a special purpose in green manuring. In fact, the roots of plants assist in promoting productiveness of the soil both by contributing organic matter and by leaving, on their decay, openings which render the soil more permeable to water and which also facilitate drainage and aëration.

Lyon, Fippin and Buckman (1921) reported that the dense mass of roots with their minute hairs that are left in the soil after every harvest furnish a well distributed supply of organic manure which is not confined to the furrow slice, as is artificially incorporated manure. They further stated that the drainage and aëration of the lower soil because of the openings left by the decomposed roots are of the greatest importance in heavy soils. The beneficial effects of clover and other deep-rooted plants are due, in no small measure, to this function.

Tephrosia candida and *Tephrosia noctiflora* have this influence in heavy soils. There is objection to the woody character of the stem which causes some difficulty in turning the plants under. The woody character appears to the writer, however, as of considerable advantage under Philippine conditions, where rapid decay is not especially desirable as the humus is "burnt out" of the soil. With crops like pineapple which require a long growing period, the slower the decay of woody stems the more beneficial for the crop.

Table 3 shows that the green manures turned under were, within a period of four weeks, almost completely eaten up by white ants, or termites. *Calopogonium muconoides* and *Indigofera hendecaphylla* were the only two plants which were not attacked by white ants.

For further observation on the white ant destruction the writer turned under some of the *calopogonium muconoides* and *Indigofera hendecaphylla* side by side with the green manure plants for which this pest had shown a liking. Three trials were made. The result remained the same. The two plants were not attacked by the white ants even after a period of two months, but the other plants were all destroyed.

The writer observed that there are many white ants on the College Campus and on the Experiment Station farm. He does not know of any beneficial effects of the white ants in this respect. Therefore, means should be devised to minimize their destructiveness if full benefit is to be received from the green manures turned under. While some green manures are not eaten by white ants when turned under side by side with susceptible ones, they may be attacked when used exclusively as green manures. Work along this line may be of great benefit to farmers, especially those who consider green manuring as a means of improving their land.

There is one very objectionable characteristic of *Indigofera hendecaphylla* as a green manure, its tendency to become a nuisance in cultivation. When turned under in all the stages, it did not die immediately or even within a period of two weeks. The growing

shoots, however, later died and in the fourth week were found to be rotting. In this particular respect, *Indigofera hendecaphylla* does not seem to meet the qualification of a green manure crop. For unless it is turned under deep and completely covered it has the tendency to send up new shoots from the buried stems. Thus it becomes a nuisance in cultivation.

Table 5 gives the average comparative yields of fertilizing materials to show the application of table 4. To present a clearer comparison of the quantity of fertilizing materials given by each green manuring plant in its various stages, the value of N_2, P_2O_5 and water-free material was calculated in kilogram per square meter of each plant gathered.

The yield of green materials as shown by weight may be misleading without proper correction for the moisture it contains. In table 4 is presented the percentage composition of the different fertilizing materials. Table 5 gives yield of fertilizing materials from each of the square meters of freshly dug up green manure. The moisture content of the plants was determined and subtracted from the initial weight of fresh green produced per square meter of each green manure. The difference multiplied by the percentage composition gives the corrected weight of fresh product for each square meter. This computation was made on only one set of planting and on only one kind of soil, hence the results are scarcely adequate for approximating various field conditions. But as the green manures used were planted and subjected to practically the same environmental conditions, the data should be of some value in helping to choose desirable green manure plants.

Table 4 gives the percentage composition of the oven-dry matter. The contents of table 4 are summarized in table 5 which shows that there was invariably an increase of dry matter from the first harvest up to the last one and an increase during the ages from four to six months. This was true of all the plants. The increase in dry matter in each of the green manures towards maturity is very marked. The increase may be accounted for by the gradual increase of fibrous tissue in the plant as it becomes older. With the coming of maturity in the plants the succulency and moisture content decreases and the dry matter increases.

Quantity of nitrogen

Table 4 shows that the percentage of nitrogen decreases as the plant becomes older. In table 5, data show that the quantity of nitrogen becomes greater per square meter of each green manure

as it advances in age. This result, therefore, shows that while the percentage of nitrogen decreases in each plant as it advances in age the quantity of nitrogen in the plants does not necessarily decrease. For the great increase of growth of plant tissues may bring about a lower proportion of nitrogen for a given weight of the plants. It is, then, the proportion of nitrogen to a given weight of the plant that decreases and not the actual quantity.

Taylor and Ghosh (1923) in reporting their experiments on green manuring of rice called attention to the fact that it is not the age of the plant alone that determines the amount of nitrogen fixed. Much depends upon the vigor and strength of the plants and the rapidity of the growth. Data in table 5 show clearly that the amount of nitrogen fixed by each of the nine green manure crops increased gradually for the first three months and abruptly in the fourth month, and decreased abruptly in the fifth month. The fifth month was October when there is usually a daily rain and considerable wind. The plants suffered much from hard winds and too much water in the soil. The leaves were partly dried by the action of the wind. The nodule bacteria were prevented from getting nitrogen from the air because the soil was saturated with water. These conditions brought about mechanical and physiological effects upon the plants. The vigor, strength and rapidity of growth were badly affected and as a consequence the amount of nitrogen was greatly reduced. It is, however, interesting, to note that *Calopogonium muconoides, Indigofera hendecaphylla* and *Tephrosia candida* seem not to have been badly affected by these adverse conditions. The explanation probably is that the first two are creeping plants so could better resist the strong winds. And *Tephrosia candida* has a very deep taproot, so although erect like the others, it has a stronger foothold in the ground so is less affected by the movement of the wind than the other green manures that have shallower taproots.

Crotalaria anagyroides gradually decreased in the quantity of nitrogen per square meter during the fourth and fifth months. Table 1 shows that this plant was bearing flowers on September 2. At this time there were a few larvae of the tiger moth (*Argina cribraria* Clerck) feeding on the flower buds. As the flowers increased more of these larvae were found. And when the plant was in full bloom not a flower was free from them. This plant was in full bloom during the ages of 3½ to 4 months. Had it not been for this heavy infestation of the tiger moth, there would have been a greater rise in the quantity of nitrogen at the age of 3½ and 4 months. When

the stormy days came some of the larvae were washed away by the rain water; consequently there was a little increase in the quantity of nitrogen on these days.

Table 5 shows the importance of green manuring in cases of lack of nitrogen. *Crotalaria usaromoensis, Tephrosia candida,* and *Crotalaria juncea* are high nitrogen yielders. *Calopogonium muconoides* was a low yielder of nitrogen during the first 3½ months, but it became the highest at the age of 5 months. *Indigofera hendecaphylla* was always low in yield of nitrogen in all the stages studied. Cowpea and mungo were found to be early maturing in comparison with the others. Cowpea gave a higher yield of nitrogen than mungo in all the three stages.

Quantity of phosphorus

The decrease in the percentage of phosphorus as the plant grows older is shown in table 4. Table 5, however, shows that the decrease in percentage shown in table 4 was due to the growth of the plant. The proportion of phosphorus to a given weight of plants becomes smaller in the older ages. The increase in the plant growth is more than sufficient to counter-balance the decrease in percentage in table 4.

SUMMARY OF CONCLUSIONS

1. The experimental data in this study indicate that of the nine plants studied, *Vigna sinensis* (Linn.) Savi and *Phaseolus aureus* Roxb. flower the earliest. These flowered in 51 and in 48 days, respectively. Second to these are *Tephrosia noctiflora* Boj., *Crotalaria usaromoensis* Bak. and *Crotalaria anagyroides* HBK requiring from 70 to 95 days. The other four required over 100 days with *Calopogonium muconoides* Desv. the latest, flowering in 145 days.

2. *Calopogonium muconoides* Desv. and *Indigofera hendecaphylla* Jacq. were not eaten by white ants when turned under, but all the other green manures were partly or wholly eaten up at the end of the fourth week.

3. *Indigofera hendecaphylla* Jacq. does not rot immediately after it is turned under; it produces shoots.

4. *Crotalaria juncea* Linn. and *Crotalaria usaramoensis* Bak. were the tallest and *Calopogonium muconoides* Desv. was the longest.

5. *Tephrosia candida* Roxb. and *Tephrosia noctiflora* Boj. had the deepest taproots, hence, may be called subsoilers.

6. There was a decided increase towards maturity in the quantity of dry matter in all the green manure plants.

7. *Crotalaria juncea* Linn. and *Crotalaria usaramoensis* Bak. yielded the greatest quantity of water-free matter per square meter.

8. The percentage of nitrogen decreased in all the plants towards maturity but the actual quantity per square meter was, however, increased because of greater size of plants.

9. *Calopogonium muconoides* Desv. and *Indigofera hendecaphylla* Jacq. which are creeping and *Tephrosia candida* Roxb. which is erect were observed to be fairly resistant to strong winds.

10. Large quantities of phosphorus were found in all the plants at the ages of four to five months.

RECOMMENDATIONS

1. If only four to seven months are available for green manuring, *Vigna sinensis* Savi, *Phaseolus aureus* Roxb., *Crotalaria usaramoensis* Bak, and *Tephrosia noctiflora* Boj., are among the best green manure crops to grow. *Tephrosia candida* Roxb., *Crotalaria juncea* Linn., and *Calopogonium muconoides* Desv., are more suitable for a longer period or several early maturing crops may be grown in succession.

2. In windy places the creeping legumes like *Calopogonium muconoides* Desv. or erect but deep-rooted plants like *Tephrosia candida* (Roxb.) DC. are recommended to be used as green manures. *Indigofera hendecaphylla* Jacq. is not recommended as it has the tendency to send out shoots when it is not completely and deeply buried in the ground. It may become a nuisance to the crop later planted.

3. If possible, means should be devised to prevent the eating by the white ants of the turned-under green manures. Or when a field is infested with white ants resistant legumes should be used, or green manuring should not be practiced.

4. Further study should be made on the value of *Calopogonium muconoides* Desv. and other legumes in order to find out more definitely whether or not, when turned under they are immune to the attack of white ants.

5. For fields that have a hard stratum below the soil, *Tephrosia candida* (Roxb.) DC. and *Tephrosia noctiflora* Boj. may be used as green manures because they serve as subsoilers at the same time.

6. In fields where there is little or no humus, legumes which are heavy yielders of dry matter may be used to advantage as green manures. *Crotalaria juncea* Linn. and *Crotalaria usaramoensis* Bak. may be recommended, especially in their advanced ages, for this purpose.

REFERENCES

BAL, D. V. 1921. Studies on the decomposition of some common green manuring plants at different stages of growth in black cotton soil of the central provinces. Agric. Jour. India 17: 133–151.

BUNTING, B., AND T. D. MARSH. 1926. Soils and manures. Tropical Agriculturist 66: 43–47.

DORYLAND, E. D. 1925. Green-manure, soiling and cover crops. Philippine Bur. Agric. Cir. 61: 1–8.

KOCH, L. 1924. The value of some green manures. Tropical Agriculturist 51: 1–6.

LAZO F. Decomposition of certain green manures as affected by certain fertilizing materials. (Thesis presented for graduation with the degree of Bachelor of Agriculture, College of Agriculture, 1929. Unpublished.)

LYON, T. L., E. O. FIPPIN, AND H. O. BUCKMAN. 1921. Soils, their properties and management. xxi + 764p., 84 fig. New York: The Macmillan Company.

LYON, T. L., AND B. D. WILSON. 1927. Some relations of green manures to the nitrogen of a soil. Cornell Univ. Agric. Exper. Sta. Meme. 115: 1–29.

MARTIN, T. L. 1921. Decomposition of green manures at different stages of growth. Cornell Univ. Agric. Exper. Sta. Bull. 406: 137–169.

JOHNSON, MAXWELL, O. A. R. THOMPSON, AND C. A. SAHR. 1917. Comparative value of legumes as green manures. Hawaii Agric. Exper. Sta. Bull. 52: 1–14.

MCKEE, R. 1910. Orchard green-manure crops in California. U. S. Bur. Plant Indus. Bull. 190: 1–37.

MILLER, H. A. 1918. A simple way to increase crop yields. U. S. Dept. Agric. Bull. 924: 1–24.

MOLEGODE, W. 1926. Green manure for paddy. Tropical Agriculturist: 66: 160-164.

PIPER, C. V. 1907. Leguminous crops for green manuring. U. S. Dept. Agric. Farmers' Bull. 278: 1–27.

PIPER, C. V., AND A. J. PIETERS. 1925. Green manuring. U. S. Dept. Agric. Farmers' Bull. 1250: 1–46.

SACKETT, W. G., ALVIN KEZER, I. W. FERGUSON, AND J. C. WARD. 1928. The effect of green manures and crop residues on soil reaction. Colorado Agric. Exper. Sta. Bull. 324: 5–31.

SORNAY, P. DE 1916. Green manures and manuring in the tropics. xvi + 466 p., 74 fig. London: John Bale, Sons & Danielson, Ltd.

TAYLOR, C. S., AND M. GHOSH. 1923. Experiment on green manuring of rice. Agric. Jour. India 18: 104–114.

WHITING, A. L., AND W. R. SCHOONOVER. 1920. The comparative rate of decomposition of green and cured clover tops in soil. Soil Sci. 9: 137–149.

TABLE 1

Showing the number of days from sowing to flowering and to maturing of the different green manure crops used

NAME OF GREEN MANURE CROPS	DATE OF		TIME NECESSARY TO	
	sowing	flowering	flower	mature
	1931	*1931*	*days*	*days*
Calopogonium muconoides Desv.	May, 28	Oct., 10	145	190
Crotalaria anagyroides HBK	May, 28	Sept., 2	97	[a]
Crotalaria juncea Linn.	May, 28	Sept., 15	101	163
Crotalaria usaromoensis Bak. f.	May, 30	Aug., 13	75	183
Indigofera hendecaphylla Jacq.	May, 30	Sept., 28	121	183
Phaseolus aureus Roxb.	May, 29	July, 16	48	61
Tephrosia candida (Roxb.) DC.	May, 28	Sept., 20	115	153
Tephrosia noctiflora Boj.	May, 28	Aug., 6	70	108
Vigna sinensis (Linn.) Savi.	May, 29	July, 16	51	71

[a] Flowers were eaten by tiger moth (*Argina cribraria Clerck*), according to identification made by the writer.

TABLE 2

Showing the average length of roots and stems and the yield of fresh matter in kilogram per square meter

NAME OF GREEN MANURE	AGE	AVERAGE LENGTH OF stem	AVERAGE LENGTH OF root	YIELD OF FRESH MATTER PER SQ. M.
	mo.	*cm.*	*cm.*	*kgm.*
Calopogonium muconoides ..	2	62.63 ± 1.1938	13.83 ± 0.3143	0.70
do	2-1/2	117.20 ± 1.0905	19.16 ± 0.2989	2.10
do	3-1/2	226.86 ± 3.1958	21.73 ± 0.5831	2.83
do	4	314.86 ± 3.0123	21.60 ± 0.5427	3.70
do	5	336.00 ± 1.9558	20.86 ± 0.4813	4.10
do	6	352.40 ± 1.8473	20.20 ± 0.4239	4.50
Crotalaria anagyroides	2	51.83 ± 0.5661	16.76 ± 0.3721	2.29
do	2-1/2	70.26 ± 0.3853	18.06 ± 0.3375	3.43
do	3-1/2	105.33 ± 0.5487	23.46 ± 0.4722	4.56
do	4	114.00 ± 0.1692	27.66 ± 0.4813	5.33
do	5	134.26 ± 0.1974	28.30 ± 0.1040	5.40
do	6	134.00 ± 0.0974	28.20 ± 0.1048	6.40
Crotalaria juncea	2	102.10 ± 0.1457	13.66 ± 0.2070	3.06
do	2-1/2	139.96 ± 0.1328	14.03 ± 0.2387	4.23
do	3-1/2	240.30 ± 0.4067	22.06 ± 0.4084	5.00
do	4	245.66 ± 0.6163	25.60 ± 0.4737	5.13
do	5	259.00 ± 0.0830	28.26 ± 0.6090	5.56
do	6	299.60 ± 0.0803	29.00 ± 0.1120	10.30
Crotalaria usaromoensis	2	47.46 ± 0.3004	14.43 ± 0.0683	1.63
do	2-1/2	83.26 ± 0.4967	15.43 ± 0.1843	2.76
do	3-1/2	136.00 ± 0.2372	16.73 ± 0.3355	4.76
do	4	143.66 ± 0.5367	19.80 ± 0.5161	5.33
do	5	182.40 ± 1.3318	23.06 ± 0.3976	6.10
do	6	236.60 ± 1.4804	22.60 ± 0.5407	8.30
Indigofera hendecaphylla ..	2	32.73 ± 0.3947	16.70 ± 0.2542	0.46
do	2-1/2	53.20 ± 0.5824	19.06 ± 0.3311	0.76
do	3-1/2	81.53 ± 0.4948	21.66 ± 0.5623	1.40
do	4	105.26 ± 0.9821	18.93 ± 0.2132	1.76
do	5	117.53 ± 1.6553	19.00 ± 0.1740	2.23
do	6	161.86 ± 1.9254	19.26 ± 0.2868	2.56
Phaseolus aureus	1	31.16 ± 0.2331	8.20 ± 0.1230	0.53
do	2	53.40 ± 0.4340	16.93 ± 0.2830	0.86
do	2-1/2	77.93 ± 0.9271	17.93 ± 0.2279	1.66
Tephrosia candida	2	51.40 ± 0.1393	13.30 ± 0.1443	1.76
do	2-1/2	78.43 ± 0.1788	19.33 ± 0.1780	2.00
do	3-1/2	101.00 ± 0.1740	24.06 ± 0.2096	3.20
do	4	118.53 ± 0.9704	31.40 ± 0.4890	4.06
do	5	133.00 ± 0.5224	38.60 ± 0.6025	4.10
do	6	139.93 ± 0.0839	39.40 ± 0.3037	4.43
Tephrosia noctiflora	2	47.13 ± 0.1017	15.66 ± 0.1346	1.26
do	2-1/2	66.27 ± 0.2476	20.40 ± 0.4544	1.60
do	3-1/2	88.13 ± 0.1958	28.13 ± 0.3153	2.36
do	4	106.00 ± 1.0655	30.33 ± 0.4910	3.50
do	5	100.13 ± 0.1247	29.80 ± 0.5435	3.43
do	6	100.00 ± 0.1471	29.53 ± 0.1844	2.80
Vigna sinensis	1	26.03 ± 0.2240	12.33 ± 0.2353	0.63
do	2	95.33 ± 0.6565	16.13 ± 0.3722	1.90
do	2-1/2	112.80 ± 1.2941	17.90 ± 0.9389	2.39

TABLE 3

Showing the results of turning under green manures to a depth of 30 centimeters; examined at 14 days intervals

NAME OF GREEN MANURES	AGE	CONDITIONS OF THE TURNED UNDER GREEN MANURE	
		after 14 days	after 28 days
	mo.		
Calopogonium muconoides ..	2	Harder portion present; no white ants around	Traces of harder portion present
do	2-1/2	do	do
do	3-1/2	do	Skeleton present
do	4	do	do
do	5	do	do
do	6	do	do
Crotalaria anagyroides	2	Harder portion present; white ants	Eaten by white ants do
do	2-1/2	do	do
do	3-1/2	do	do
do	4	Rotting; no white ants	
do	5	do	do
do	6	do	do
Crotalaria juncea	2	Harder portion present; white ants	do
do	2-1/2	do	do
do	3-1/2	Rotting; no white ants	Being eaten by white ants
do	4	do	do
do	5	do	do
do	6	do	do
Crotalaria usaromoensis	2	Harder portion present; white ants around	do
do	2-1/2	do	do
do	3-1/2	do	do
do	4	Rotting; no white ants	
do	5	do	do
do	6	do	do
Indigofera hendecaphylla ...	2	Shoots growing inside	Harder portion present
do	2-1/2	do	do
do	3-1/2	do	do
do	4	do	do
do	5	do	do
do	6	do	do
Phaseolus aureus	1	Traces of harder portion present	No parts found; no white ants
do	2	Hard portion present; white ants	Eaten by white ants
do	2-1/2	do	do
Tephrosia candida	2	Harder portion present; white ants around	Eaten by white ants
do	2-1/2	do	Being eaten by white ants
do	3-1/2	Rotting; no white ants	do
do	4	do	do
do	5	do	do
do	6	do	do
Tephrosia noctiflora	2	Harder portion present; white ants around	Eaten by white ants
do	2-1/2	do	do
do	3-1/2	Rotting; no white ants	Being eaten by white ants
do	4	do	do
do	5	do	do
do	6	do	do
Vigna sinensis	1	Traces of harder portion present	No parts found; no white ants around
do	2	Being eaten by white ants	Eaten by white ants
do	2-1/2	do	do

TABLE 4

Showing the relative chemical composition of nine green manuring plants in terms of percentages calculated on oven-dry samples

NAME OF GREEN MANURES	AGE	OVEN-DRY PERCENTAGES OF		
		nitrogen (N)	phosphorus (P205)	water-free product
	mo.			
Calopogonium muconoides ...	2	3.05	0.68	10.47
do	2-1/2	2.70	0.68	10.67
do	3-1/2	1.89	0.02	19.58
do	4	2.70	0.93	25.85
do	5	2.97	0.85	36.75
do	6	2.22	1.16	37.08
Crotalaria anagyroides	2	2.56	0.62	16.15
do	2-1/2	2.33	0.88	24.94
do	3-1/2	2.46	0.60	23.25
do	4	1.56	0.49	24.81
do	5	1.62	0.83	26.18
do	6	1.89	0.47	23.47
Crotalaria juncea	2	5.41	0.67	15.60
do	2-1/2	2.48	0.80	22.62
do	3-1/2	1.76	0.41	34.61
do	4	1.85	0.73	33.59
do	5	1.57	0.38	39.80
do	6	0.74	0.24	38.51
Crotalaria usaromoensis	2	7.46	0.31	14.68
do	2-1/2	2.99	0.70	24.60
do	3-1/2	2.63	0.54	19.16
do	4	2.73	0.37	34.19
do	5	1.96	0.22	34.32
do	6	1.46	0.24	44.13
Indigofera hendecaphylla	2	2.37	0.44	29.61
do	2-1/2	2.61	0.73	19.41
do	3-1/2	2.73	0.59	26.95
do	4	2.17	0.80	34.47
do	5	2.30	0.91	26.13
do	6	1.83	0.29	49.39
Phaseolus aureus	1	6.33	1.31	15.68
do	2	3.75	1.07	16.93
do	2-1/2	2.95	0.47	32.44
Tephrosia candida	2	3.75	0.84	24.94
do	2-1/2	1.89	0.59	37.69
do	3-1/2	2.86	0.48	34.55
do	4	2.38	0.73	63.31
do	5	2.46	0.67	47.51
do	6	2.46	1.18	38.44
Tephrosia noctiflora	2	2.38	0.66	25.24
do	2-1/2	2.24	0.73	35.60
do	3-1/2	2.80	0.81	27.07
do	4	2.46	0.67	44.17
do	5	1.87	1.03	38.76
do	6	2.05	0.27	64.21
Vigna sinensis	1	3.28	0.72	15.37
do	2	3.30	0.93	20.86
do	2-1/2	3.03	0.99	28.13

TABLE 5

Showing the comparative yields of fertilizing materials of nine green manuring plants calculated in grams per square meter of fresh matter

NAME OF GREEN MANURES	AGE	YIELD IN GRAMS PER SQUARE METER OF		
		nitrogen (N)	phosphorus (P205)	water-free product
	mo.			
Calopogonium muconoides ..	2	2.23	0.49	73.2
do	2-1/2	6.04	1.52	224.0
do	3-1/2	10.47	4.54	554.1
do	4	25.82	8.89	956.4
do	5	49.11	14.05	1,653.7
do	6	37.04	19.35	1,668.6
Crotalaria anagyroides	2	9.46	2.29	369.8
do	2-1/2	19.93	7.52	855.4
do	3-1/2	26.08	6.36	1,060.2
do	4	20.62	6.47	1,322.3
do	5	22.90	11.73	1,413.7
do	6	28.38	7.05	1,502.0
Crotalaria juncea	2	25.82	3.19	477.3
do	2-1/2	23.72	7.65	956.8
do	3-1/3	30.45	7.09	1,730.5
do	4	31.87	12.57	1,723.1
do	5	34.74	8.40	2,212.8
do	6	29.35	9.12	3,960.5
Crotalaria usaromoensis	2	17.84	.74	235.2
do	2-1/2	20.29	4.75	678.9
do	3-1/2	23.19	4.92	912.0
do	4	49.74	6.74	1,822.3
do	5	41.03	4.66	2,093.5
do	6	53.47	8.79	3,662.7
Indigofera hendecaphylla	2	3.22	0.59	136.2
do	2-1/2	3.84	1.07	147.5
do	3-1/2	10.30	2.22	377.3
do	4	13.16	4.85	606.6
do	5	13.39	5.30	582.6
do	6	23.13	3.66	1,264.3
Phaseolus aureus	1	5.26	1.08	83.1
do	2	5.45	1.55	145.5
do	2-1/2	15.88	2.53	538.5
Tephrosia candida	2	16.45	3.68	438.9
do	2-1/2	29.20	9.11	1,545.2
do	3-1/2	31.62	5.30	1,105.6
do	4	35.08	10.76	1,474.1
do	5	47.91	10.05	1,947.9
do	6	41.78	20.04	1,698.4
Tephrosia noctiflora	2	7.56	2.09	318.0
do	2-1/2	12.75	4.15	569.6
do	3-1/2	13.26	3.83	473.6
do	4	38.02	10.35	1,449.9
do	5	24.85	13.69	1,329.4
do	6	36.35	4.85	1,797.8
Vigna sinensis	1	3.17	0.69	96.8
do	2	13.07	3.68	396.3
do	2-1/2	19.27	6.57	663.8

ABSTRACTS [1]

Study of second and third year selection of seedling sugar canes grown in 1928–1929 cane breeding season in the College of Agriculture. GUILLERMO L. CANLAS. (*Thesis presented for graduation, 1932, from the College of Agriculture, with the degree of Bachelor of Agriculture No. 429; Experiment Station contribution No. 983.*)—The objects of this work were: (*a*) to study some of the agronomic characters of the P. B. (Plant Breeding) cane and talahib seedlings grown during 1928–1929 season; and (*b*) to eliminate the undesirable individuals and begin propagating the promising ones.

The author used 73 seedling cane varieties which were selected at the first harvest from 1,370 seedlings selected for transplanting from 9,729 seedlings.

The cuttings were planted singly in the field at a distance of 80 × 50 cm.

At maturity the results showed that in the second year selection based mainly upon the weight of cane per stool, quality ratio, and percentage of total solids, 52 seedlings were chosen for planting and 21 seedlings were discarded. In the third year the selection was made more rigid being based upon the number of millable and non-millable stalks, the degree of disease infection, average height of each seedling variety, average diameter of millable stalks at maturity, yield per stool, and chemical analysis of each cane variety. Out of the 52 seedlings 24 were selected and 28 were eliminated. In the fourth year selection, 14 seedlings were chosen 12 of which were of sugar cane parentage and two were selected from 11 talahib seedling canes. The remaining 10 seedlings were discarded. Mosaic, Fiji, smut, and leaf scald were the major diseases of the seedling canes. Two selected P. B. seedlings were attacked by smut and leaf scald, but the rest of the seedlings were free from any of the major diseases.

—*Abstract by Francisco Helardo*'

---

[1] Abstracts prepared as part of required theme work in English 3a, College of Agriculture.

Culture of ubi, nami and tugué in different soils as an intercrop with some permanent planting. FRANCISCO B. SANTOS. (*Thesis presented 1918, for graduation with the degree of Bachelor of Agriculture from the College of Agriculture No. 430; Experiment Station contribution No. 984.*)—The object of this experiment was to determine the production of *Dioscorea* in different soils when given the same kind of cultural conditions and when used as intercrops with some permanent planting.

Twenty-two varieties of *Dioscorea* harvested from the College Farm were used. These varieties were planted in four different types of field prepared in the same way as for corn, beans, or gabi. The same spacing (1.5 by 1.5 meters) was used with each variety.

The author's results were: In field I where the soil was heavy clay and had been previously planted to corn the yield was low ranging from 1,293.2 to 10,865.58 kgm. to the hectare. In field II which had been used for pasture continuously for several years the yields of the same varieties as were planted in field I were relatively high. In field III where the soil was deep, black and contained humus and had been previously planted to beans and peas the yields of the same varieties as were planted in field I were much better than in field II. In field IV situated along the banks of a river where the soil was alluvial the yields were lower than in fields II and III. The best yielding varieties in field IV were *tugué* (88-Small); Binaksan (*329*) (College variety number); *ubi* (*938*); *yam,* variety Hinaligue (*956*); *yam,* variety Lagkitan (*952*); *yam,* variety Kinahoy na Puti (*953*); *yam,* variety Dinaliri (*960*); *ubi,* variety Ligao (*1369*); *ubi,* variety Kiriwi (*1560*); *ubi,* variety Labak (*1561*); *ubi,* variety Luklok (*962*); and Balolong Pute (*2612*); the yields ranging from 10,665.60 to 52, 439.20 kgm. to the hectare. The curing of the tuber for planting with slaked lime, ash, powdered soil and drying the cut surfaces gave satisfactory results. For poling, bamboo poles (5 by 125 centimeters) gave more satisfactory service than the ipilipil, *Leucaena glauca* (Linn.) Benth. poles. The length of maturity of each variety varied from 5 to 10 to 12 months. The crowbar was found to be the best implement for digging deep growing yams.

The author arrived at the following conclusions:

1. In places where plow and carabao can be used, planting by rows would be the most economical and convenient method.

2. Newly opened porous soil is best for *Dioscorea.*

3. Not advisable to plant *Dioscorea* in clay soil.

4. Stable manure appears to be of great importance in increasing the yield of *Dioscorea.*

5. The yield of *Dioscorea* is influenced by location of field, texture of the soil and to a great extent by the previous crops grown in the fields.

—*Abstract by Porfirio R. Manacop*

KERNELS

"CORN FROM THE SHEAVES OF SCIENCE"

The efficiency of four kinds of animal protein (shrimp meal, meat scraps, tankage and fish meal) added to a basal ration consisting of rice bran and corn meal was tested for growing chicks. The results were conclusive in showing that in points of rate of growth, sexual maturity and percentage of hatchability some kind of protein feed was better than no protein. Of the supplements used the shrimp meal was the best, tankage the poorest.

The seeds of "buñga" (*Aeginetia indica* Linn.), a phanerogamic parasite of the root of sugar cane, are resistant to heat. Burning of straw or pouring of boiling water does not destroy the viability of "buñga" seeds. Their germination is accelerated by heat.

Prevent the spread of coconut bud rot by cutting down all infected trees and burning their crowns to ashes.

When trained, capons become excellent "nurses", some being even better than hens in taking care of the chicks.

Experiments with albino rats showed that the common Filipino food materials contain the essentials that make for longevity, fertility, size, good appearance, etc.

Albino rats on a diet rich in fruits and vegetables were more prolific than those on a diet rich in meat and fish. But the meat group were larger, had smoother fur and were better looking than the vegetable group.

A duck egg has a higher nutritive value than a chicken egg, and costs less.

Do not plant cool climate plants in warm climate localities or *vice versa,* because disease is often the limiting factor in these cases.

The Saba variety of banana when fully ripe is more digestible when raw than when cooked.

CURRENT NOTES

Most European breeds of cattle in the tropics appear to retain the cold climate characteristic of growing a heavy winter coat. Periodic clipping of the hair is therefore a great relief to such animals during hot weather and facilitates the destruction of ticks. The long hair makes excellent cover for these parasites and affords protection against poisonous sprays applied to destroy them.

The fine hair of the Jerseys, in comparison to the rough coats of the Friesians, makes them more suitable in this respect for the tropics.

For keeping the hair of stock short a hand-power flexible shaft-drive clipping machine, as commonly used for horses, has been employed with success on the farm.

With regard to the control of ticks, the policy at Serdang is to spray all animals with an arsenical cattle dip once a week. In addition, any casual ticks which may gain access to the stock in the interval between spraying operations are removed by hand-picking during grooming.

Malayan Agricultural Journal May, 1934.

Farm efficiency is applied methodical common sense in the running and management of the farm.

Firstly dealing with machinery, many farmers are too busy or hard pushed for time ever to read the instruction book. Careful study of the instruction book will pay very big dividends in the life of a machine.

With internal combustion engines, use only the best oil and greases, for when a farmer has to pay several hundreds of pounds for a machine, it is worth while to put that little difference in price between poor and good lubrication into that machine, for in all cases good lubrication pays.

See that the fuel—whether for car, engine, or tractor—is strained. This, in the long run, will prove a time saver. One may go perhaps for months without trouble through not straining the fuel, and then, perhaps, miss an important engagement, or lose several hours with blocked fuel pipes.

Always clean gauze strainers at certain periods, for even with the best strainers sediment gets through.

When emptying oil tins or drums, be careful of the last drop, for it is usually in this that the water and rubbish collects, and unless strained may ruin expensive bearings.

Keep your eyes and ears open, and if you see or hear something wrong, stop and remedy it unless it is trivial, even then it pays, for "a stitch in time saves nine," and nothing is surer than that adage when applied to fast moving machinery.

When feeding cows, pigs, horses &c., always have the feeding utensils in a convenient place.

Do not leave implements in a far corner of the farm; they may be needed later, and time will be lost in getting any parts or tools that are required. A. McCallum *in a paper read at a farmers' conference at Morchard, S. A.*

Queensland Agricultural Journal October, 1933

Dried Apricot and Pineapple Jam. 1lb. dried apricots, 2qt. water, 4lb. sugar, 1 cut up pineapple. Cover apricots with boiling water in which 1 teaspoon soda has been added. Soak ½ an hour. Pour off water, then add 2qt. cold water. Stand 24 hours. Bring to boil, adding pineapple and sugar.

The Journal of the Department of Agriculture of South Australia September, 1933

Tropical agricultural development in Queensland has become a matter of major importance.

When the solvency of any particular territory depends on a single form of production that locality is hostage to fortune. This fact has been forcibly if painfully demonstrated during the past few years in our exclusively pastoral areas of the West.

Queensland Agricultural Journal February, 1934

In the little country of Denmark there are 22 Agricultural Schools with 2897 students. The schools are all privately owned but receive State grants. Here there is both practical training and the theoretical instruction and the courses are for periods less than a year. The students are practical farmers and farmer's sons * * *

What will benefit our villager is a network of such practical schools for adults for short terms where the educated unemployed and young villagers can labour and earn their livelihood while under training. Government aid will be necessary in the earlier stages.

The Madras Agricultural Journal March, 1934

COLLEGE AND ALUMNI NOTES

Contrary to the usual tourist "stunt" of spending practically all of a hurried visit to the Philippines in shopping in Manila and dashing to Baguio and back, Dr. George B. Cressey, chairman of the Department of Geology and Geography, Syracuse University, in early September spent all of his short time in the Islands on our Campus and travelling in the country in this part of Luzon. After his departure from the Philippines, Dr. Cressey wrote of the work of the Soils Department: "I feel that you are making a very significant contribution to our knowledge of the Philippines." For some years Dr. Cressey was on the faculty of Shanghai College; during that time he travelled extensively both in China proper and in Mongolia. His outstanding book on China: "China's Geographic Foundations" is the result of his studies of that country and her people.

Dr. Ira Condit, Professor of Pomology of the University of California at Los Angeles, at present an exchange professor in Lingnan University, Canton, China, was a recent Campus visitor. Professor Condit gave an illustrated lecture before the Los Baños Biological Club on the history and development of the common fig of commerce. He conferred with Dr. Leon Gonzalez of the Division of Horticulture about some important features of Philippine fruits. He was the guest at a faculty luncheon at Molawin Hall.

Prof. S. R. Gandhi, Assistant Horticulturist of the Poona Agricultural College, India, spent a few days of his stay in the Philippines on the Campus. He was interested in some of the tropical fruits and fruit plants and their methods of propagation. Professor Gandhi spent most of his time in the College nursery where he made observations on the nursery practices and the methods of propagating fruit plants. He visited Doctor Mendiola's personal collection of introduced fruit plants on Faculty Hill and was particularly attracted to the kapulasan (*Nephelium mutabile* Blume) from Java which was fruiting.

Mr. Fernando de Peralta, B. S. A. '22 detailed for two years for graduate study in the University of Nebraska returned recently with the degree of Ph. D. in Plant Ecology. He took his major work under Prof. J. E. Weaver, the well known Plant Ecologist. Doctor Peralta has the distinction of being the first, and at present the only Filipino Plant Ecologist.

A letter has just been received from Rao Bahadur T. S. Venkatraman, Government Sugar Cane Expert, Imperial Sugar Cane Station, South India ordering one cane juice squeezer devised by Mr. Toribio Mercado of the Department of Agronomy, a description of which appeared in a recent issue of the *Sugar News.*

Colonel Paulino Santos, Director of Prisons and Governor Dionisio Gutierrez of Cotabato were Campus visitors on September 8. They were shown around by Doctor Mendiola and conferred with Doctors Villegas, Fronda and Leon Gonzalez. They were especially interested in the live stock and poultry work and experiments of the College.

Captain E. V. Misa, Superintendent of the Iwahig Penal Colony and Mr. Pablo of the Davao Penal Colony, both of the Bureau of Prisons, visited the Department of Agronomy on September 4 to see the College Japanese rice thresher brought here from Japan by Dean Gonzalez. This thresher has been tested for threshing rice harvested during the wet season and found rather unsatisfactory. It will be tested with dry season rice the coming summer.

Dr. Mamerta Felizardo and Pura U. Llamas of the Manila College of Pharmacy and Dentistry spent the morning of September 1 in studying the different medicinal plants in the stock cultures of the Department of Agronomy. They were supplied with 168 specimens from 15 species of medicinal plants for further study and for herbarium collections.

A group of Japanese students under the leadership of Mr. K. Midzutani of the School of Foreign Languages in Tenri, Tambaichi, Nara, Japan included the College in their itinerary.

Prof. V. Lontok, Acting Secretary-Treasurer of the University is one of the heavy purchasers of planting materials from the College.

In addition to the 200 seedlings of Robusta coffee which he ordered in the latter part of July, he has ordered another set of 200 seedlings of each of the varieties, Excelsa and Robusta coffee, 400 seedlings of caimito, 30 carabao mango seedlings and some avocado plants.

Dr. D. V. Villadolid '19 together with Messrs. Alonte '30 and Franco of the Fish and Game Division came to the College recently to get planting materials of ornamental plants to be used in beautifying the Fish and Game Administration Office in Manila. Dr. D. V. Villadolid was formerly Assistant Professor of Zoölogy in the Department of Entomology.

At the request of Mr. Thongdee Resananda B. S. '24, now Director of Department of Agriculture, Siam, Doctor Fronda of the College Poultry Division had shipped to him from a Philippine poultry farm three Los Baños Cantonese roosters and twelve hens and two Nagoya roosters and ten hens. We quote in part from Director Resananda's letter acknowledging arrival of the fowls.

> At present although reared in an unscientific way, poultry forms an industry quite important in both the local and foreign trade of Siam. Over a million ticals worth of chickens are exported annually to the nearby markets and about three times that number are consumed locally. (Tical equals about 80 centavos.)
>
> I shall make considerable effort to develop poultry raising. You have demonstrated what can be done in this industry.
>
> My dear Doctor, please do not forget that in Siam you have many devoted College of Agriculture students of whom I am one.

Mr. Resananda's major subject in College was poultry.

Judge Benigno T. Sarayba of General Trias, Cavite was a recent Campus visitor. He conferred with Mr. Aragon of the Division of Annual Farm Crops about the culture of soybeans and peanut and examined the seeds of these plants. Judge Sarayba left an order for 50 cavans of Valencia peanut and two cavans of soybean seeds for planting on his farm in Cavite. He also conferred with Doctor Mendiola and Doctor Baltazar about cotton culture.

There have been several recent Campus visitors who came because of their interest in cassava. Among these were: Mr. Barretto of Calamba who came to observe the College cassava starch factory. He also visited the cassava fields in the Experiment Station. Mr. Barretto is planning to interest a group of cane planters in planting cassava and later on in establishing a starch factory.

Mr. Atanasio Hizon '28 together with Mr. Ramon and Anacleto Hizon and Mr. Justino A. David were among recent visitors who came to look into the culture and manufacture of cassava starch, culture of soybeans and the manufacture of toyo. They were shown by Dr. Pedro A. David the starch factory and the Division of Annual Farm Crops where experiments on the manufacture of toyo are in progress.

Mrs. Isabel Uijanco Madlambayan, a sugar planter of Mabalacat, Pampanga, together with her two sons and an overseer spent a morning in visiting the College starch factory and the cassava fields in the Experiment Station. They were interested in cassava culture and cassava starch manufacture. They left an order for 200 meters of cuttings of some of the high yielding varieties of cassava of the College.

Mr. and Mrs. Gil Exconde of San Pablo, Laguna came to the Department of Agronomy to confer with Mr. Aragon about the culture of cassava. They are planning to establish a cassava factory. They bought 1,000 meters of cassava cuttings to be planted on their farm. In addition to cassava they are planning to open an extensive avocado orchard. Mr. Exconde left an order for 1,000 budded avocado plants.

Among visitors showing special interest in coffee, tobacco, soybean and peanuts were: Rev. Gabriel Vivar, Mr. Mariano Alda and Mr. Julio Colivo of the Philippine Sugar Estate at Calamba. They were interested in the culture of coffee and cacao and conferred with Doctor David about these crops. They purchased planting materials to be used for trial plantings.

Don Potenciano Malvar of San Pablo, Laguna came on September 4 to buy 4,000 seedlings of Robusta coffee. He left an order for 40 budded avocado plants.

Mr. Eliseo Carandang '33 at present connected with the Hacienda Caylaway, Nasugbu, Batangas came to the College to confer with Dr. E. P. Baltazar about the construction of a flue curing house and to consult some references on tobacco in the College Library. The Hacienda at Nasugbu, according to Mr. Carandang, is producing excellent crops of tobacco but the proper curing is something of a problem.

Mr. Francisco Valdez '30 together with his brother Lorenzo Valdez '33 and Mr. Herminio Suarez came to confer with Mr. Ara-

gon about the culture of soybean, peanut, cassava and the manufacture of soy sauce or toyo from the locally grown Ami soybeans. Mr. Suarez bought one cavan of selected soybean seeds for planting. The Valdez brothers are farming in Angeles, Pampanga.

Mr. Gerido, cotton specialist of the Bureau of Plant Industry came to the College recently to confer with Doctor Baltazar about the identification of cotton varieties. He visited the College cotton fields.

The ninety-fourth regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Poultry Building, College of Agriculture, on Thursday, July 26, at 7:30 p. m.

The following papers were read and discussed.

"Top-working undesirable santol trees"

By Dr. L. G. Gonzalez

"The anatomy and morphology of the 'buñga', *Aeginetia indica* Linn."

By Dr. J. B. Juliano

The ninety-fifth regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Poultry Building, College of Agriculture, on Thursday, August 30, 1934, at 7:30 p. m.

The following papers were read and discussed.

"Coconut honey"

By Dr. G. A. Guazon

"Effects of heat upon the viability of 'buñga' seeds, *Aeginetia indica* Linn."

By Dr. R. B. Espino and Mr. F. Pantaleon.
Paper read by Mr. Pantaleon

The Higamot Hill in the College Experiment Station has recently been cleared and the small guard's house on top of it converted into a bamboo and cogon rest house for the students and faculty members working in the fields east of the railroad tracks. The rest house commands a view of the fields of the Experiment Station from along one side of the Animal Husbandry pastures to the provincial road going to Bay. Several faculty members and their wives including Dean and Mrs. Gonzalez and some bachelor members "opened" the house with a whole day *lechonada* picnic.

In a letter to Mr. Vicente B. Aragon, Mr. A. Benitez '33 reports that he is teaching in the Zambales Rural High School. To show that his job is no sinecure we quote from his letter: "I am teaching Animal Husbandry, Entomology, Farm Crops and Algebra. I am also in charge of the poultry, swine and carabao and cattle projects of the school and coach the basket ball and baseball teams."

Mr. Crispulo Bagui '22 was a recent Campus visitor. He made arrangements with Doctor Mendiola, of the Department of Agronomy for the exchange of some planting materials from the Economic Development Office of Batangas, Batangas for some fruit plants of the College. Mr. Bagui is the Provincial Agricultural Inspector of Batangas and has been assigned as head of the agricultural section of the Economic Development office of Batangas.

Dr. Pedro A. David received a letter from Mr. Antonio P. Flores '34 who is employed in the Pacific Commercial Company, reporting that he had been put in charge of the P. C. C. coffee and pickle plant. He requested Doctor David to furnish him with a list of publications on the manufacture of coffee.

When you're all tired out and ready to drop,
And men's ways seem mean and vile,
Don't frown and scowl and glare at the world—
Surprise them all with a smile.
'Twill take less out of your tired old hulk,
'Twill tide you over awhile;
For it takes sixty-four muscles to fashion a frown
And only thirteen for a smile.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

THE CELEBRATION ON OUR SILVER ANNIVERSARY[1]

The festivities in connection with the Silver Anniversary of the founding of the College were held on October 10, 1934 instead of on June 14, which would have been more accurate. October 10 has long been recognized as an official day of the College, very appropriately called "Loyalty Day," in commemoration of the wholesale enlistment of the College constituency—faculty, students, and employees—for service in the World War on that day in 1918, so that the celebration partook of a double nature.

The first and the most important public event, because of its lasting influence, in connection with the celebration, was the publication of a special number of the PHILIPPINE AGRICULTURIST, which was released on October 1. The articles published summarized the results of investigational work accomplished by the College during its twenty-five years of existence, presented by departments in accordance with the present organization of the College. In view of the varying age, of the different units of the College, their relative importance and the size of the personnel, the amount of work accomplished by each differs considerably. Also, with a simpler organization in the beginning certain lines of work initiated in one department were later taken up by others that were organized subsequently. As an example, initial work on soils, plant pathology and irrigation was done in the Department of Agronomy. Again, certain lines of work more appropriately agronomical were pursued in the early days by the departments of Plant Physiology and Agricultural Chemistry.

In the interest of economy and conciseness, it became necessary to abbreviate the articles considerably, reducing reports in some cases to a mere mention of lines of work pursued, omitting altogether the presentation of detailed results. Any one interested in these details can follow up the specific articles most of which were published in the PHILIPPINE AGRICULTURIST, or can write to us for the original information.

On the eve of Loyalty Day a gorgeous pageant was presented at Baker Memorial Hall under the direction of Professor Anne F. Cole, assisted by Professor Harriett L. Richards as director of the

---

[1] General contribution from the College of Agriculture No. 436.

THE PHILIPPINE AGRICULTURIST, VOL. XXIII, NO. 7, DECEMBER, 1934

singing. This pageant depicted the part played by the College in the rational development of the agricultural industries of the Islands and its promise of further usefulness.

Early in the morning of October 10 the slumberers were awakened by a band parading around the Campus. The participants in the Anniversary and Loyalty Day Parade busied themselves with their last minute preparations and by nine-thirty everything was in readiness. Upon arrival of the Hon. Claro M. Recto, President of the Constitutional Convention, and after inspecting his Guard of Honor, the parade started from the Entrance Gate, marched through Royal Palm Avenue and Animal Husbandry Road, to Baker Memorial Hall. The guest of honor, with President Bocobo of the University and the Dean of the College, reviewed the parade from the balcony of Baker Hall.

The Anniversary ceremonies followed at ten-thirty. After a march by the Cadet Band the Rev. Hugh Bousman, student pastor of the United Evangelical Church, offered the invocation. This was followed by the University of the Philippines Hymn, "U. P. Beloved". Dean Gonzalez of the College then spoke on the significance of the day, emphasizing the thought that "Celebration of memorable dates are held not necessarily for exultation in past deeds, much less for self-elevation, but rather in rededication to lofty self-imposed obligations, to the spirit of service and self-sacrifice that one must feel towards his constituency, to the defense of common interests, to loyalty to principles that give consideration to the right of others, but equally determined to demand respect for one's own rights." The occasion was signally honored by the presence of Dr. Edwin Bingham Copeland, founder and first dean of the College, who is now connected with the Department of Agriculture and Commerce as technical adviser. He was the next speaker, and he addressed himself particularly to the October graduates, giving them words of counsel and encouragement in their future endeavors.

After a selection played by the Cadet Band, President Bocobo introduced the guest of honor as "a brilliant scholar and a foremost writer". The Honorable Recto, who in addition to being President of the Constitutional Assembly is also floor leader of the majority party in the Senate, spoke very eloquently in English. He was greatly impressed by the parade, the exposition, and the spirit of the occasion. He delivered an inspired address on the need of developing our natural resources for the benefit of the new nation, and the part to be played by the College and its graduates in direct-

ing their logical exploitation. He also exalted the spirit of loyalty, calling it "the most beautiful word in the lexicon of patriotism and of service".

Dean Gonzalez then announced the units in the parade that the judges voted best. The first place was awarded to the Agricultural Engineers, the second place to the Associated Women Students, and the third to the Sugar Technology group.

A large delegation of alumni of the College attended the celebration and formed a unit in the parade. Every class from the first one in 1911 to the last one in 1934 was represented. Prizes in the form of framed pictures of College views were awarded to Mr. Basilio Hernandez '22 as the most loyal alumnus, to Dr. Toribio Vibar '12 as the oldest alumnus in attendance, to Mr. Francisco B. Santos '18 of Davao as the alumnus who travelled farthest to attend the "home-coming", to Mr. Francisco G. Galang '14 for having contributed the most to the country's population. Recognition was also given to Mr. Evett D. Hester, economic adviser to the Governor-General, as the most loyal faculty alumnus, to Dr. Edwin B. Copeland as the oldest faculty alumnus, and to Col. Paulino Santos, Director of the Bureau of Prisons, as the most loyal adopted alumnus.

At the close of the convocation, Dean Gonzalez administered the Oath of Loyalty:

> I, a student of the University of the Philippines, do solemnly promise to cherish the spirit so nobly typified by the faculty and students in the critical year of nineteen eighteen. I pledge my loyalty and allegiance to that ideal for which they offered their services, and I will do all in my power to hasten the day when peace and mutual good-will shall prevail among all races and nations of the earth. May God help me keep this vow to my Alma Mater and to my country, and to the principles of truth, fraternity and citizenship for which they stand.

The program closed with the singing of the College song, "Hail College Dear" by the assembly.

Under the managership of Dr. F. O. Santos a luncheon was served to about five hundred official guests in the Seed Laboratory. The Makiling Ladies Club, whose membership consists of wives of members of the faculties of the College of Agriculture and the School of Forestry, conducted a canteen in Molawin Hall and served lunch and refreshments throughout the day.

After luncheon the guest of honor inspected the College Exposition. In addition to the College departments, the School of

Forestry, the U. P. Rural High School, the Calamba Sugar Estate, the Orcar Farm, the Bureau of Plant Industry, the International Harvester Company, the Pacific Commercial Company, and the Manila Trading and Supply Company contributed valuable exhibits. The exhibits of the College revealed largely the results of its work on original investigations and in the development of manufactures from locally grown agricultural products. Visitors were greatly impressed with the wealth of local products that can be manufactured into objects that are now largely imported.

During the afternoon the different departments of the College held open house. They welcomed visitors not only to their exhibits at Baker Memorial Hall but also to their buildings and explained to them their activities and work in progress. The Department of Animal Husbandry held special demonstration on spaying sows and cows, filling silo and feeding silage to cattle and carabaos, dipping cattle for ticks, baling hay, and making ham, bacon and sausage.

The field activities in the afternoon consisted of a sham battle by College Cadets, under the direction of Lt. Amado Martelino, and a soccer football game between De La Salle College and the University of the Philippines.

Different members of the faculty were hosts for dinner to friends staying for the evening events.

In the evening, two activities were held simultaneously. A literary joust by vernacular poets took place in Baker Hall under the sponsorship of La Yebana Cigar Co., and a popular dance was held at the Seniors' Social Garden. Both affairs were more than well attended and lasted well into the night.

One very significant feature in connection with the celebration was the excellent weather that prevailed throughout. In spite of the fact that it is still the rainy season and typhoons hovered around the locality both before and after October 10, the day itself was as pleasant as could be desired and permitted the carrying out of the program of activities as scheduled without any hitch or delay.

This account would be incomplete without noting the names of those most conspicuously responsible for the success of the affair, even at the risk of being guilty of serious omissions. In addition to those already mentioned, the lion's share of the credit undoubtedly belongs to Dr. N. B. Mendiola, professor of agronomy, who was chairman of the executive committee of the celebration. Miss Emma S. Yule was in charge of the special number of the PHILIPPINE AGRICULTURIST, Dr. R. L. Pendleton of the illustrations, Dr. F. M. Sacay of the alumni home-coming, Dr. R. B. Espino and Mr. N.

Machan of the athletic events, Dr. A. V. Ascalon of the popular dance, Dr. A. L. Teodoro of constructions, Messrs. V. M. Dawis and M. Villaluz of decorations, Mr. J. R. Arana of arrangements and traffic, Dr. L. G. Gonzalez of finance, Dr. F. M. Fronda and Mr. A. V. Yñiguez of invitations, Dr. M. Manresa of parade and program, Dr. L. B. Uichanco of publicity, Dr. D. I. Aquino of music, Miss E. Fraser of Makiling School participation, Mr. E. Agudo of Boy Scouts, Dr. V. Villegas of participation of outside entities and Mr. Fernando de los Reyes of student participation.

In any worthy enterprise there is always a large number of unnamed workers whose only compensation lies in the satisfaction of having done a good piece of work well. Every member of the College community did his part faithfully and cheerfully as duty and opportunity presented; no better demonstration of institutional loyalty could have been found. All are entitled to credit for the success of the celebrations.

B. M. Gonzalez
Dean, College of Agriculture

One of the major problems which confront librarians and the publishers of scholarly works is that of the deterioration of the paper upon which the publications are printed.

At the University of California Press we believe we have solved the problem by printing a special edition of 25 copies of our scientific works on a permanent, 100 per cent rag paper, and distributing these copies to a selected list of depositories throughout the world.

Publishers have a duty to posterity; particularly those who, like ourselves, are engaged in preserving the results of original research. Consciousness of this ought to compel us to print our publications on material that will last. But much intervenes between duty and practise, and, as a result, important discoveries are being published so shoddily that within the century their record will be lost.

Late in 1933 the University of California Press, recognizing its obligation to future scholars, initiated the new method of publishing which has been described.—Samuel T. Farquiar.

Science, July 8, 1934.

The best government is still that which governs least and educates most.—Will Durant.

THE PROXIMATE CHEMICAL COMPOSITION OF THE SEED AND OIL OF PHILIPPINE OIL-BEARING SEEDS: I. POÑGAMIA PINNATA MERR.[1]

FLORENCIO A. SOLIVEN
Of the Department of Agricultural Chemistry

WITH TWO TEXT FIGURES

Among the forty-five species of oil-bearing seeds analyzed by Padilla and Soliven (1933), it was found that the seed of *Poñgamia pinnata* Merr. contained a fair amount of oil. This plant is known in the Philippine Islands under different local names as *bani* (Pangasinan, Zambales, Pampanga, Bataan and the Ilocos provinces); *balik-balik* (Tagalog); *kadel* (Tayabas); *marok-barok* (Bicol); *salingkugi* (Zamboanga). According to Brown (1920), the species of plant is distributed in the forests from northern Luzon to southern Mindanao. No regular plantation is known to have been established of *Poñgamia pinnata* except for the few plants set in a semi-plantation style, by the Division of Forest Studies and Research of the Bureau of Forestry at Los Baños, Laguna.

As the seed contains a high percentage of oil, a systematic study of the composition of the oil and of the kernel should be of interest.

Literature on the chemical composition of the seed and the oil of *Poñgamia pinnata* Merr. is wanting. The few chemical constants or characteristics reported by West and Brown (1920) for the oil from its seeds are not constants for the oil from the seeds of this plant. They are obtained from *The Chemical Technology and Analyses of Oils, Fats and Waxes* by Lewkowitsch (1921). According to this author the source of the oil he analyzed and reported in this book was *Poñgamia glabra*. The oil of *Poñgamia glabra* has been studied also by Jamieson (1932) and Desai, Sudurrough and Watson (1933). In table 1 are given the characteristics of the oil of *Poñgamia glabra* and *Poñgamia pinnata* Merr.

---

[1] Experiment Station contribution No. 985. Read before the Los Baños Biological Club, February 15, 1934. Received for publication August 7, 1934.

THE EXPERIMENTAL PART

Preparation of the oil

The seeds used in this study were very kindly supplied by the Division of Forest Studies and Research, Bureau of Forestry at Los Baños. According to Padilla and Soliven (1933), the seed is composed of 94.13 per cent kernel and 5.87 per cent shell (table 2).

The seeds were ground through a meat grinder and the oil contained in the kernels extracted with ether by means of an improvised Soxhlet apparatus (fig. 1). The last traces of ether in the oil was removed by steaming the oil. The moist oil was then treated with anhydrous sodium sulfate for the purpose of dehydrating it. The mixture was then filtered off and the oil thus obtained used in this study.

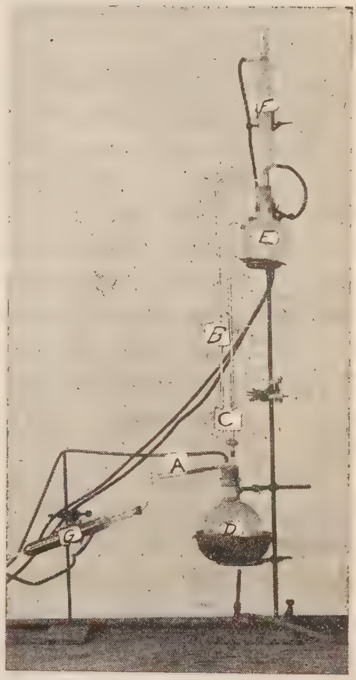


Fig. 1.—An improvised Soxhlet apparatus. (*A*) Pressure tubing connected to suction (to be used only in case the liquid in *E* containing the dissolved oil fails to syphon to *D*); (*B*) passage of vaporized solvent from *D* to *E*; (*C*) passage of the condensed solvent carrying the oil from *E* to *D*; (*D*) reservoir for the solution of oil in the solvent; (*E*) Ballon flask containing the sample from which the oil is extracted; (*F*) spiral condenser for condensing the vaporized solvent from *D* before it comes in contact with the sample; (*G*) spiral condenser for the recovery of the solvent. (If this is used the stopcocks at *C* and *D* should be closed).

The composition of the kernels

The composition of the seeds having been previously studied by Padilla and Soliven (1933) their figures were used (table 2).

It may be seen from this table that the kernels have a fairly high crude fat content. This seed yields a greater amount of crude fat per kilogram of seeds than lumbang (Padilla and Soliven (1933). It is equally rich in proteins and carbohydrates, so the cakes after the removal of the oil might be used advantageously as feed for live stock. A feeding test, however, would be necessary before it could be so used.

The composition of the ash

Table 3 gives the composition of the ash from the kernels after the oil has been extracted. This was determined for the purpose of ascertaining its value as a filler for fertilizer.

The ash from the cake was found to be rich in ferric oxide and alumina, there being 42.11 per cent of the said constituents in the ash. Of these, 29.52 per cent is due to ferric oxide alone. It was also found that there is a fair amount of lime, potash and sodium oxide. The composition of the cake shows that it may be utilized as fillers in the compounding of certain grades of commercial fertilizers.

The physical properties of the oil

The oil is clear and in a thin layer has a very light yellowish orange tint and when in moderate thickness is yellowish orange. On standing at room temperature for some time solid globules separate from the clear oil and adhere to the sides of the receptacle. The oil has a rather disagreeable odor and a somewhat bitter taste.

The specific gravity of the oil, as determined by means of pycnometer, was found on an average to be 0.9310 at 30°C. The index of refraction found by the Abbé-refractometer was 1.4713 at 30°C. The oil is liquid at ordinary temperature.

The chemical properties of the oil

The constants given in table 1 for the oil of *Poñgamia pinnata* Merr. represents the averages of from six to eight concordant determinations. These were determined for the purpose of ascertaining the general properties of the oil as well as to furnish a means of ready comparison with other oils, particularly with the oil from the seeds of *Poñgamia glabra.* Judging from the iodine value of the oil of *Poñgamia pinnata* Merr. it may be classified, following Jamieson (1932), as a non-drying oil. It contains a small amount of unsaponifiable matter and a fairly low acid value. The saponification value was found to be fairly high. In general, the properties of the oil of *Poñgamia pinnata* Merr. are much the same as the properties of the oil of *Poñgamia glabra* as reported by Jamieson (1932), but their compositions are not quite the same.

The proximate composition of the oil

The unsaturated fatty acids were separated from the saturated fatty acids in the neutral oil by the lead salt-ether-method.

The method of resolution of the neutral oil into the saturated fatty acid fraction and the unsaturated acid fraction was the one devised by Gusserrow and Varrentrapp (1903) as cited by Lewkowitsch (1921). The method involves the conversion of the glycerides into their corresponding lead salts in which the saturated acids are insoluble in dry ethyl ether, but the unsaturated acids are soluble.

The method of separation is not, however, very complete as some of the salts of the unsaturated fatty acids always stay with the residue. At any rate, from the iodine value of the unsaturated fraction and that of the saturated fraction, the corrected amount of these two fractions could easily be calculated. Table 4 gives the results of six sets of separation.

It may be readily seen from table 4 that the neutral oil is composed of 22.67 per cent saturated or solid acids and 75.71 per cent liquid or unsaturated acids, or 23.04 per cent solid acids and 76.96 per cent liquid acids on the basis of 100 parts.

The physical and chemical characteristics of the unsaturated fatty acids

The mixture of the unsaturated fatty acids obtained by the lead-salt-ether method was found to have the physical and chemical characteristics given in table 5.

It may be seen in this table that the iodine value of the sample lies between that of the theoretical values for the acids of the linolenic, linoleic and oleic series. It might be said that the oil from the seeds of *Poñgamia pinnata* Merr. are composed of a mixture of these acids. The saponification value is fairly high. Like the iodine value, the mean molecular weight indicates that the mixture might be that of the three acids named above. The iodine number of pure oleic acid has been found to be 90.00 and its molecular weight is 282.36. The iodine number for linolenic acid is 270.00 and its molecular weight is 278. The iodine number of linoleic acid is 180 and its molecular weight is 280.35. The observed iodine and mean molecular weight values are 165.82 and 221.75, respectively.

Examination of the liquid acids by the bromo-derivative method

The bromine addition derivatives of the liquid fatty acids were prepared in accordance with the method of Eiber and Muggenthaler (1902) as cited by Lewkowitsch (1921). Table 6 shows the results obtained.

It was found in repeated trials that during and after bromination no precipitates were found which were insoluble in ethyl ether. Of the fatty acids known, the bromo-derivative of linolenic acid is the only one that is insoluble in dry ethyl ether. It may be concluded, therefore, that the liquid fatty acid fraction did not contain any of the acids belonging to the linolenic acid series. Hence, the neutral oil does not contain any acid of this series.

Fig. 2.—A branch of *Poñgamia pinnata* Merr. showing the bunches of fruits.

When the ether was completely removed and a low boiling petroleum ether was used instead, crystals were formed, two crops of these crystals were recovered, and weighed, as shown in table 5. The crystals recovered had bromine content and melting point similar to the theoretical values for pure linoleic acid. The presence of such crystals was a conclusive proof of the presence of acids belonging to the linoleic acid series. The presence of some more linoleic acid derivatives in the residue after the second crop of linoleic crystals were removed was shown by the rather high bromine content of such residue. The average bromine content of the residues found was 50.75 per cent. The bromine content of pure oleic acid derivative is 36.18 per cent and pure linoleic acid derivative, 53.33 per cent. It was evident that the residue was a mixture of the tetrabromide and the dibromide of linoleic and oleic acids.

From the weight of the two crops of crystals isolated and the bromine content of the weighed residue the total amount of bromo-derivative due to linoleic acid was calculated and also that of the oleic acid found in the residue mixed with the tetrabromo-derivative. It was found that the liquid acids were composed of 14.69 per cent of acids belonging to the oleic acid series and 85.31 per cent of acids belonging to the linoleic series.

The percentage of linoleic and oleic acids in the unsaturated acids converted to the percentages of glycerides in the original oil is 11.75 for oleic glyceride and 68.28 for linoleic glyceride (table 7).

The iodine value of a mixture of 14.69 per cent oleic acid and 85.31 per cent linoleic acid is 167.004. These figures agree fairly well with the observed iodine value of the unsaturated fatty acids which is 165.82. The neutral oil was found to be composed of 11.75 per cent oleic glyceride and 68.28 per cent linoleic glyceride.

The saturated fatty acids

The physical and chemical properties of the saturated acid fractions prepared above are given in table 8.

The iodine value was found to be fairly high, indicating the presence of unsaturated acids mixed with the saturated acids. The saponification number was found to be fairly high. The mixture of acids, despite the presence of unsaturated acids, was still solid at ordinary temperature as shown by the rather high melting and solidifying points of the sample. The mean molecular weight indicates that the saturated acids obtained might be mixtures of stearic and palmitic acids. The individual acids were not isolated owing to lack of proper facilities in the department.

Table 9 gives the composition of the oil obtained from the seeds of both *Poñgamia pinnata* Merr. and *Poñgamia glabra.*

It may be readily seen from this table that the oil of *Poñgamia glabra* was composed mostly of oleic acid. On the other hand, the oil of *Poñgamia pinnata* Merr. was found to be composed mostly of linoleic acid with a comparatively small amount of oleic acid. The oil of *Poñgamia glabra* was found to contain also a small amount of linolenic acid, but in *Poñgamia pinnata* oil, no linolenic acid was found.

SUMMARY

1. The seed of *Poñgamia pinnata* Merr. is composed of 94.13 per cent kernel and 5.87 per cent shell.
2. The kernel contains 26.63 per cent yellowish orange oil.
3. The kernel was found to have the following composition:

	Per cent
Moisture	12.41
Ash	3.05
Protein	23.29
Crude fat	26.63
Carbohydrate	32.62

It would seem that the cake derived from the extraction of the oil might be utilized as feed for live stock as the amount of carbohydrate and protein constitutes more than fifty per cent of the kernel.

4. The ash from the kernel was found to have the following composition:

	Per cent
Insoluble matter and silica	4.22
Ferric oxide and alumina	42.11
Phosphoric acid anhydride	8.93
Calcium oxide	17.89
Potassium oxide	17.37
Sodium oxide	26.82

The cake resulting from the extraction of the oil may have value as source of fertilizer or as filler in the compounding of certain grade of commercial fertilizer.

5. The oil is composed of 76.96 per cent liquid acids and 23.04 per cent solid acids.

6. The liquid acids are composed of 14.69 per cent oleic acid and 85.31 per cent linoleic acid or 11.30 per cent oleic acid and 65.65 per cent linoleic acid expressed on the basis of the original oil. Oleic acid predominates in the oil of *Poñgamia glabra,* while in the oil of *Poñgamia pinnata* linoleic acid predominates.

LITERATURE CITED

JAMIESON, GEORGE, S. 1932. Vegetables fats and oils. 444 p. New York: The Chemical Catalog Co. Inc.

LEWKOWITSCH, JULIUS ISODOR. 1921. Chemical technology and analysis of oils, fats and waxes. 6th ed. Rewritten and enlarged; edited by George H. Washburton, Vol. 1, xvii + 682 p., 59 fig. vol. II., xii + 959 p. 19 fig. London: Macmillan and Co., Ltd.

PADILLA, SALVADOR, AND FLORENCIO A. SOLIVEN. 1933. Chemical analysis for possible sources of oils of forty-five species of oil-bearing seeds. The Philippine Agriculturist 22: 408-415.

WEST, AUGUSTUS P., AND WILLIAM H. BROWN. 1920. Philippine resins, seed oils and essential oils. Philippine Bureau of Forestry Bulletin, 20: 1-230.

TABLE 1

Showing the chemical constants of the oil of Poñgamia pinnata and Poñgamia glabra

	POÑGAMIA GLABRA		POÑGAMIA PINNATA
	Lewkowitsch	Jamieson	
Specific gravity	0.9352	0.9420	0.9310
Refractive index Butyro	78.00		
Abbe		1.4697 to 1.4723	1.4713 to 1.4719
Iodine number	89.40 to 94.00	83.00 to 94.00	91.09 to 95.79
Saponification value	171.00 to 185.10	177.00 189.00	180.30
Melting point (°C.)	+ 2.0		
Acid value	42.28		22.35
Unsaponifiable matter	8.16	2.4 to 9.0	2.60
R. M. value		1.04 to 1.10	

TABLE 2

Showing the composition of the kernel

CONSTITUENTS	FRESH BASIS	MOISTURE FREE-BASIS
	per cent	*per cent*
Kernel	94.13	—
Shell	5.87	—
Moisture	12.41	—
Ash	3.05	3.49
Protein (6.25 × N)	23.29	26.59
Crude fat	26.63	32.68
Carbohydrates (by difference)	34.62	39.78

TABLE 3

Showing the composition of the ash

CONSTITUENTS	FOUND	ON THE BASIS OF THE KERNEL
	per cent	*per cent*
Insoluble matter and silica	4.22	0.15
Ferric oxide and alumina	42.11	1.47
Ferric oxide	29.52	0.90
Aluminum oxide, etc.	12.59	0.57
Calcium oxide	17.89	0.62
Potassium oxide	17.37	0.61
Sodium oxide	9.32	0.33
Phosphoric acid anhydride	8.93	0.31
Total	99.84	3.49

TABLE 4

Showing the separation of the unsaturated acids from the saturated acids in the neutral oil

NUMBER OF TRIAL	WEIGHT OF OIL USED	SOLID ACIDS		LIQUID ACIDS	
	grams	*grams*	*per cent*	*grams*	*per cent*
1	9.8236	2.1376	21.76	7.4581	75.92
2	7.1372	1.5352	21.51	5.4500	76.36
3	4.9330	1.1228	22.76	3.7185	75.38
4	4.4110	1.0322	23.40	3.3537	76.03
5	10.5632	2.5690	24.32	7.8051	73.89
6	9.8570	2.1981	22.30	7.5574	76.67
Average	—	—	22.67	—	75.71
Raised to the basis of 100			23.04	—	76.96

TABLE 5

Showing the physical and chemical characteristics of the unsaturated fatty acids

CHARACTERISTICS	VALUE
Melting point (°C.)	–6° to –7°
Solidifying point (°C.)	–5° to –6°
Refractive index (Abbe) at 30°C.	1.3776
Iodine value (Hanus)	165.82
Saponification value	207.39
Saponification equivalent	270.52
Mean molecular weight	221.75

TABLE 6

Showing the composition of the fatty acids by the bromo-derivative method

	I	II	III	IV	V
Weight of acid used (grams)	8.7932	14.5188	8.4916	8.8750	10.5518
Ether insoluble bromide (grams)	None	None	None	None	None
First crop of tetrabromide (grams)	2.9809	4.9184	2.5676	3.0860	3.7032
Melting point °C.	114° to 114.58		—	—	—
Bromine content (per cent)	53.15	53.15	53.15	53.15	53.15
Second crop of tetrabromide (grams)	1.8794	3.1010	1.7938	1.9738	2.3686
Melting point °C.	112.5° – 113.0°		—	—	—
Bromine content (per cent)	52.80	52.80	52.80	52.80	52.80
Weight of residual derivative	12.9632	21.3898	12.2514	13.0672	15.6808
Bromine content (per cent)	50.67	50.72	50.98	50.62	50.78
Dibromide in residue (grams)	2.0495	3.3818	1.7507	2.0659	2.4792
Tetrabromide in residue (grams)	10.9137	18.0080	11.5007	11.0013	13.2016
Total tetrabromide found (grams)	15.7740	26.9331	15.7621	16.0611	19.2734
Total dibromide found (grams)	2.0495	3.3818	1.7507	2.0659	2.4792
Linoleic acid found (grams)	7.3759	12.1698	7.3750	7.5102	9.0122
Oleic acid found (grams)	1.3056	2.1542	1.1170	1.3181	1.5818
Percentage of:					
Linoleic acid	83.88	83.82	86.85	83.72	85.31
Oleic acid	14.87	14.83	13.15	14.85	14.99

TABLE 7

Showing the percentages of linoleic and oleic glycerides in the oil

	FOUND	CALCULATED ON BASIS OF 100 PER CENT	ORIGINAL OIL	GLYCERIDE IN ORIGINAL OIL
	per cent	*per cent*	*per cent*	*per cent*
Oleic acid	14.54	14.69	11.30	11.75
Linoleic acid	84.52	85.31	65.65	68.28
Total	99.06	100.00	76.95	80.03

TABLE 8

Showing the constants for the saturated acids

CHARACTERISTICS	VALUES
Melting point	66.0° to 66.5°C.
Solidifying point	64.0° to 65.0°C.
Iodine number	12.51
Saponification value	203.85
Saponification equivalent	275.22
Mean molecular weight	275.69

TABLE 9

Showing the composition of the oil of Poñgamia glabra and of Poñgamia pinnata

CONSTITUENTS	POÑGAMIA GLABRA	POÑGAMIA PINNATA
	per cent	*per cent*
Oleic acid	61.30	11.30
Linoleic acid	9.72	65.65
Linolenic acid	0.46	0.00
Saturated acids	—	23.04
Dihydroxy-stearic acid	4.40	—
Myristic acid	0.23	—
Palmitic acid	6.06	—
Arachidic acid	0.30	—
Stearic acid	2.20	—
Lignoceric acid	3.22	—
Total	85.89	99.99

HEMATOLOGICAL STUDIES ON CATTLE: I. THE HEMOGLOBIN, ERYTHROCYTES AND LEUCOCYTES IN DIFFERENT BREEDS OF CATTLE IN THE COLLEGE OF AGRICULTURE [1]

MIGUEL MANRESA AND NICOMEDES C. REYES

INTRODUCTION

Years of experience in adapting various breeds of live stock imported from foreign countries into the Philippines have shown the general futility of the work as regards most of the highly improved breeds coming from temperate regions. In general, the percentage of mortality is high. In those animals that are born and raised in the country from purebred parents, rapid degenerative changes occur. In his report to the Secretary of the Interior in 1910, Mr. C. M. Conner, Acting Director of Philippine Bureau of Agriculture, concluded thus: "A sufficient length of time has been given to this matter to settle practically once and for all the inadvisability of growing purebred cattle from the temperate zone." The work in the College of Agriculture, University of the Philippines has confirmed the general validity of this conclusion not only for cattle but for other kinds of live stock (Gonzalez, 1926).

These unfavorable results have been attributed to such agents as climate, lack of adequate feeds, improper management, occurrence of diseases not present in the homes of origin, etc. In most cases, however, the animals that die do not show specific pathological lesions. About ten years ago the idea occurred to Dr. B. M. Gonzalez, Professor of Animal Husbandry and now Dean of the College of Agriculture, University of the Philippines that perhaps studies on the hemoglobin of the animal might give some clue as to the cause of the impoverished constitution and lowered vitality of the imported animals. He sent a Chester White boar to the College of Veterinary Science for treatment because the animal was so weak that it could

[1] The greater part of the data in this paper were in a thesis presented by the junior author for graduation in March, 1934, with the degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 431; Experiment Station contribution No. 986. The thesis was prepared under the direction of the senior author.

Read before the Los Baños Biological Club in February, 1934.
Received for publication on July 25, 1934.

not support itself on its legs. Dr. C. H. Schultz who took charge of the case reported that very thorough general and special examinations convinced him that there was nothing wrong with the animal except that the hemoglobin index was extremely low. As soon as materials and laboratory facilities became available in the Department of Animal Husbandry the experiment reported in this paper was started. The writers do not know of any work having been done in the Philippines to determine how a certain method of management affects the hemoglobin, red and white blood cells of the different breeds of cattle in the Philippines. This paper constitutes the first of a series of experiments on hematology being undertaken in the Department of Animal Husbandry, College of Agriculture.

Past work on the subject

Using the Cohen and Smith method, McCay (1931) determined the hemoglobin values for the cows of various breeds in grams per 100 ml. of blood as follows: Holstein 10.6 ± 0.47; Ayrshire 10.7 ± 0.61; Guernsey 10.4 ± 0.44; and Jersey 10.5 ± 0.32. He stated that there is no relation between the hemoglobin of the cow as to breed, milk production, fat production and the prolongation of the lactation period; and that there is no change in the hemoglobin of the blood that can be related to the period of gestation or lactation.

According to the finding of Brooks and Hughes (1931) the individuality of the animal seems to be the most important factor in causing variations from the normal hemoglobin content of the blood. They state that such factors as breed, age, and prolonged fasting do not seem to affect appreciably the hemoglobin content of the blood and that no significant variation is observed from day to day. The authors summarize the hemoglobin content of the blood of the different breeds of dairy cattle which they studied as follows: Jersey 11.60 ± 0.203; Guernsey 10.34 ± 0.125; Ayrshire 11.44 ± 0.178; and Holstein 11.10 ± 0.081.

Studying the hemoglobin content in normal cattle and those suffering from a disease known as "salt sick" in Florida, Neal and Becker (1933) found such marked differences between normal and diseased animals as: in the normal, 10.94 ± 1.54 to 11.06 ± 1.40; and in the sick cattle, 4.81 to 9.04 grams per 100 ml. of blood. They stated that in the very anemic animals the values may be as low as 3.02 grams per 100 ml., and a value as low as 1.37 grams per 100 ml. had been observed shortly before death.

Objects of the present work

The objects of this experiment were as follows: To determine: (*a*) hemoglobin indices of the blood of the different breeds of cattle in the College of Agriculture; (*b*) whether hemoglobin content varies with age and condition of the animal or with the stages in the reproductive cycle; (*c*) whether the hemoglobin indices and the red blood cells maintain a constant relationship; (*d*) whether the hemoglobin indices and the white blood cells have reciprocal relationship; and (*e*) whether the hemoglobin index can be used as a guide in selecting cattle for adaptability to local environment.

MATERIALS AND METHODS OF PROCEDURE

Animals used

Thirty-four animals representing the different breeds of cattle in the College and the crosses therefrom were selected, using about four animals in each group. These animals are listed in table 1.

Technique used for the sampling of blood and hemoglobin and cell determinations

A small area on the outer surface of the ear of the animal was cleaned and the hair cut very short. After using the usual antiseptic precaution, a small vein was punctured with a lancet. The first two or three drops of blood were allowed to fall before the drops for the sample were collected. The hemoglobin indices were determined both by the Talqvist and the Newcomer improved methods of hemoglobin determinations. Three samples were taken and the average of the three was accepted as the index for the day.

Blood cell determinations were made in accordance with the formula given by Burnett (1917) using Carl Zeiss hematocytometer. In all cases the counts were made on a level stage of the microscope under magnification $\times$ 440. The average number of red blood cells (erythrocytes) from 256 little squares in three different samples, constituted the red blood cell count for the day. From the white blood cells (leucocytes) the average from 768 little squares constituted the count for the day.

These determinations were taken every thirty days; at this time the condition of the animal was carefully noted and recorded, special emphasis being laid on live weight, reproductive cycle, condition of the hair and health of the animal. The studies herein reported covered a period of nineteen months.

DISCUSSION OF RESULTS

The amount of hemoglobin per 100 ml. of blood in the different breeds of cattle in the College of Agriculture

Table 2 shows the average amount of hemoglobin per 100 ml. of blood in four breeds of cattle in the College of Agriculture. In this table it will be noted that according to the results of this study the Indian Nellore breed of cattle had the highest amount of hemoglobin in the blood, with an average of 9.87 ± 0.09. The Philippine Native cattle which closely approached the Nellores had an average of 9.43 ± 0.13 grams hemoglobin per 100 ml. of blood. The Holstein cattle which occupied the third place had an average of 8.28 ± 0.17 grams hemoglobin per 100 ml. of blood. The hemoglobin content of Holstein is significantly lower than those reported by McCay (1931) and Brooks and Hughes (1931) for the Holstein breed of cattle in the states of New York and Kansas in America. The Herefords which occupied the fourth place had an average of 6.76 ± 0.11 grams hemoglobin per 100 ml. of blood.

When subjected to statistical treatment it was found that the Nellore and the Native cattle did not differ significantly in hemoglobin content of blood per 100 ml. But the Native cattle had significantly higher hemoglobin content than the Hereford or Holstein-Friesian. The hemoglobin content of the Nellore when compared with that of the Hereford gave a difference which was 22 times its probable error, showing the significance of the difference in hemoglobin in favor of the Nellore. That the Nellores also had greater hemoglobin content than the Holstein-Friesian cattle is quite obvious. On the other hand, comparing the hemoglobin content of the Holstein with that of the Hereford the Holstein was significantly higher. When the data obtained in the present work were compared with those reported by Neal and Brooks (1933) for normal cattle under conditions obtaining in the state of Florida, U. S., it was found that the Native and the Nellore breeds compare favorably with the healthy cattle in that state. But the hemoglobins of Holstein and Hereford cattle in the Philippines were decidedly lower than those reported by Neal and Brooks (1933) for healthy animals.

The hemoglobin content of the blood of the Nellore breed of Indian cattle and of the Philippine Native, as observed in the present study, when compared with those found by McCay (1931) in the Holstein, Ayrshire, Guernsey and Jersey breeds of European cattle, do not differ significantly when statistically treated, but the hemoglobin contents of the Holsteins and the Herefords found in this study were very much lower than those reported by this investigator.

Variation of hemoglobin content of the blood of cattle with age, condition of the animal or with the stages in the reproductive cycle

Age. Table 3 shows the average amount of hemoglobin in the blood of animals of different ages. For the purposes of comparison the youngest and the oldest animals in their respective groups were selected. It will be noted that in the case of the Nellores, Juda, aged ten months at the beginning of the experiment, gave an average of 10.00 ± 0.11 grams hemoglobin per 100 ml. of blood, while Blanca, an animal 7 years and 10 months old gave an average of 9.77 ± 0.13. When treated statistically, it was found that in hemoglobin content of the blood the older animals did not differ significantly from the younger ones.

In the Native cattle, Omana aged one month at the beginning of the experiment, gave an average of 9.39 ± 0.24 grams hemoglobin per 100 ml. of blood while Tomas, an 8-year old bull gave an average of 9.77 ± 0.31. The difference was 0.96 times its probable error, hence not significant.

From the Hereford group, Mary aged 4 years and 7 months at the beginning of the experiment, gave an average of 7.66 ± 0.14 grams hemoglobin per 100 ml. of blood, while Miss Perfection, about 13 years old, gave an average of 7.77 ± 0.14. The difference was 0.57 times its probable error.

From the Holstein group, Ford aged 9 months at the beginning of the experiment gave an average of 6.38 ± 0.13 grams hemoglobin per 100 ml. of blood, while Martin, a bull 3 years and 4 months old, gave an average of 10.22 ± 0.09. The difference was 23.66 times its probable error.

Considering the results obtained from the comparisons just made it is apparent that they are inconsistent. Undoubtedly, other factors besides age interfere with the results but even when all other factors are similar the degree of variation may be high or low. It may be stated, therefore, that the hemoglobin content of the blood of animals of the same breeding may be more or may be less in the younger than the more mature animals.

These results are in agreement with those of Brooks and Hughes (1931) who worked on the hemoglobin content of the blood of various breeds of dairy cattle. They stated that there seems to be no significant relationship between the age of the animal and the hemoglobin content of the blood.

These findings are further supported by Neal and Becker (1933) in their investigations on the hemoglobin content of the blood of healthy and of anemic cattle. They stated that calves may or may

not have a higher concentration of hemoglobin in their blood than the cows.

Condition of the animal. Table 4 shows the hemoglobin of animals in good and in poor condition. Only the animals most strikingly different from their respective breeds are compared as to condition.

In the Herefords, Mary, one of those among the best in condition, and Dolly, the poorest in condition, were selected from the group and compared. Mary had an average of 7.66 ± 0.14 grams hemoglobin during the whole period, and Dolly, an average of only 4.94 ± 0.83. There was a significant difference in favor of the animal in good condition.

From the Holstein group, Martin, in the best of condition, had an average of 10.22 ± 0.09 grams hemoglobin at the end of the experiment, while Ford in poor condition had an average of only 6.38 ± 0.13. There was a decidedly significant difference in favor of the animal in good condition.

Martin and Mary were observed to be in good condition throughout the whole period of the experiment, while Ford and Dolly were always in poor condition.

From these comparisons it may be concluded that the condition of the animal affects the hemoglobin content of the blood. These findings agree with those of Neal and Becker (1933) who report that the concentration of hemoglobin in very anemic animals may be as low as 3.02 grams per 100 ml. of blood.

Stages in the reproductive cycle. In table 5 is shown the hemoglobin content of the blood of cows before and after calving and the average hemoglobin content in the blood during the period of study. It appears that the amount of hemoglobin in the blood before calving and after calving is not consistently different. By comparing the hemoglobin under column "before calving" with the average for the period, a slight decrease in the hemoglobin value before calving was noticed but, again, this decrease was not consistent. On the other hand, the hemoglobin after calving showed great variability when compared with the average hemoglobin for the whole period. The stages in the reproductive cycle in cows may affect, to a very slight degree, the hemoglobin content of the blood.

These results seem to agree with the findings of McCay (1931) who reported no change in the hemoglobin of the blood that can be related to the period of gestation. Burnett (1917) finds also that

normal pregnancy seems not to affect the number of red corpuscles and that parturition seems to lower the count for a short time.

Relationship between the hemoglobin and the red blood cells

Table 6 shows the relationship between the hemoglobin and the red blood cells from animals of different breeds. It may be seen in the table that the correlation coefficients between the hemoglobin per 100 ml. of blood and the number of red blood cells per cubic millimeter were not lower than 0.525 but not higher than 0.731, but all these correlations were uniformly significant, showing that there was a direct reciprocal relationship between the hemoglobin of the blood and the number of red cells. The absence of a perfect correlation indicated that other factors than the number of red blood cells were concerned in the hemoglobin value of the blood.

These results were expected, because by definition the hemoglobin is a crystalline compound of hematin and globin forming the principal parts of the solid constituents of the red blood corpuscles. All other things being equal the more cells there are per unit of volume the higher the hemoglobin index.

Do the hemoglobin and the white blood cells maintain a constant relationship

Table 7 shows the coefficient of correlation between the percentage hemoglobin and white blood cells in animals of different breeding. It will be noted that the coefficients varied from very low to practically zero and with the exception of the Hereford and Native cattle these correlations were not significant. These data suggest that the white blood cells do not influence the hemoglobin indices consistently.

Can the hemoglobin index be used as a guide in selecting cattle for adaptability to local conditions

According to data in table 2 which gives a brief summary of the hemoglobin in the blood of four breeds of cattle in the College of Agriculture, it appears that the Nellore stands highest, followed by the Native, Holstein and the Hereford ranking in order named. Actual observations of these four breeds of cattle would seem to show that the degree of hardiness of each breed is proportionately correlated with the hemoglobin content of their blood. The Nellores which had the highest amount of hemoglobin in their blood appear to feel at home in the College pastures. Their high degree

of inherent or natural hardiness to tropical climate seems to be a factor in favor of their survival as well as for the normal perpetuation of their species in the Philippines.

The native cattle no doubt is as well suited to the Philippines as the Nellore breed. The hemoglobin contents of blood of these two breeds were not significantly different.

As to the Holstein-Friesian cattle which had a fairly high amount of hemoglobin, their degree of hardiness under local conditions at Los Baños is as yet doubtful. Notwithstanding the special care in the feeding and management given to them some of the animals studied were undersized. Although they still survive, this does not necessarily mean that they can become a permanent breed in the country. It may be said that they are still undergoing a process of acclimatization.

Although with a low hemoglobin content in their blood, the Herefords in the College of Agriculture are still holding on, and, although somewhat undersized, they are breeding fairly regularly.

Table 8 shows the hemoglobin in the blood of the crossbreed animals and the comparisons made with the Native and the Nellore.

It may be seen from these groups of animals that of the four crosses made, so far the Nellore-Native combination seems to be the best. The average hemoglobin content of their blood was found to be 9.65 ± 0.20 grams per 100 ml. of blood, which is not significantly different from that of either the Native or the pure Nellore.

The Nellore-Hereford combination had an average of 8.94 ± 0.13 grams hemoglobin per 100 ml. of blood. This value was lower than that of the Philippine Native cattle although the difference was not significant. However, the hemoglobin of the Nellore-Hereford crosses was significantly lower than that of the pure breed Nellore.

The Nellore-Holstein cross had an average of 8.96 ± 0.09 grams hemoglobin. When compared with the Native cattle this cross was not significantly lower in hemoglobin content, but when compared with the Nellore cattle, it was.

The Native-Hereford combination had an average of 8.85 ± 0.13 grams hemoglobin per 100 ml. of blood. Treated statistically the Nellore and Native cattle each had higher than this cross in hemoglobin per 100 ml. of blood.

Grouping these animals as to their relative merits and demerits when judged on the basis of hemoglobin content of the blood, it will be seen that the Nellore-Native, Nellore-Hereford and Nellore-Holstein crosses did not differ from the Native cattle by a signifi-

cant value in hemoglobin. Of these crosses, only the Nellore-Native cross did not differ from the Nellore. On the other hand, the Native-Hereford combination differed from the Native by a significant value. Also, the Nellore-Holstein, the Nellore-Hereford and the Native-Hereford differed by a significant value from the Nellore.

Actual field observations of the herds of cattle in the College of Agriculture indicate that the Nellore-Native cross is probably the best combination, possessing the adaptability of the Native and the hardiness and resistance of the Nellore. The animals from this cross age for age weigh more than the Native cattle and in some cases are larger than the Nellore, but in most cases they are about equal. They reproduce normally and the rate of growth of the calf seems to be faster than that of the Native calf. In point of weight, Carambas (1932) reported that the Nellore-Hereford cross both male and female, after it has attained maturity, that is from 50 to 72 months old, is heavier than the Nellore-Native. Before that age the results are not consistent.

The Nellore-Hereford cross as judged on the basis of hemoglobin value stood intermediate between the Nellore and the Hereford. The crossbreeds are larger than the Herefords but a little smaller than the Nellore and with general body comformation approaching Herefords. In the Nellore-Hereford crosses, Carambas (1932) found that this combination had an advantage in weight over the pure Nellore and the Nellore-Native in the male only after 18 months of age.

The Nellore-Holstein combination produces animals that seem to be smaller than either the sire or the dam. They are able to survive but not able to maintain a uniform muscle covering of their body frame work indicating low constitutional vigor.

The Native-Hereford combination produces animals that are able to survive under local environment. Carambas (1932) makes this statement "all Native grades irrespective of sex are better than the Natives. All Hereford grades are better than pure Herefords, but not all the Nellore grades are better than the Nellores." With one possible exception, the Hereford-Native combination when compared with the pure Native, this statement applies when the animals are judged on the basis of the hemoglobin content of the blood. It is quite likely that the difference in the hemoglobin (0.58 $\pm$ 0.18) between the pure Native (9.43 $\pm$ 0.09) and the Hereford-Native combination (8.85 $\pm$ 0.13) may be very important in showing that

the pure Native is better adapted to the environmental conditions in Los Baños than the Hereford-Native crosses.

It is interesting that the hemoglobin determinations closely agree with field observations of the different breeds of cattle and the crosses therefrom in their adaptability under Los Baños conditions of feeding, care and management. The hemoglobin content of the blood may, therefore, be used as a guide in selection for adaptability to a given set of environmental conditions.

Table 9 shows the coefficients of correlations of results from hemoglobin determinations obtained by the Talqvist and the Newcomer methods. In this table it may be seen that a very significant correlation existed between the two methods. The data in table 5 show that the hemoglobin and the red blood corpuscles maintained a fairly close agreement. It would seem, then, that either the Talqvist or the Newcomer method may be used as a guide in selection. In the absence of both, the red blood cell count may be used.

For laboratory examination, the counting of the red blood corpuscles may be recommended but because of the cost a person of ordinary means will not be able to equip himself with the necessary instruments. For a more accurate determination of the hemoglobin the Newcomer method is the best, for the range of error is said to be very small. But because this apparatus is delicate its use in the field does not seem practical. Although the Talqvist method is accurate only to the extent of 10 per cent it may be used instead of the more accurate Newcomer apparatus.

SUMMARY AND CONCLUSIONS

1. The amount of hemoglobin per 100 ml. of blood in the different breeds of cattle in the College of Agriculture were as follows: Nellore 9.87 ± 0.09, Native 9.43 ± 0.13, Holstein 8.28 ± 0.17 and Hereford 6.76 ± 0.11. When treated statistically the hemoglobin of the Nellore was not significantly higher than that of the Native, but was significantly higher than the Hereford or the Holstein. The hemoglobin of the Native was significantly higher than that of the Hereford or the Holstein; and that of the Holstein was higher than that of the Hereford.

2. The amount of hemoglobin per 100 ml. of blood in each of the four crosses of cattle studied was as follows: Nellore-Native 9.65 ± 0.20, Nellore-Holstein 8.96 ± 0.09, Nellore-Hereford 8.94 ± 0.13, Native-Hereford 8.85 ± 0.13. When treated statistically the following crosses, Nellore-Native, Nellore-Hereford and Nellore-Holstein did not differ in hemoglobin from the Native; and the

Nellore-Native did not differ from the Nellore. The Native-Hereford differed in hemoglobin from the Native; and the Nellore-Holstein, the Nellore-Hereford and the Native-Hereford differed from the Nellore.

3. The condition of the animal greatly affected the hemoglobin content of the blood.

4. There was no correlation between the hemoglobin index and the number of leucocytes in the blood of cattle.

5. Correlation coefficients varying from 0.525 ± 0.044 to 0.731 ± 0.036 between the hemoglobin value of the blood and the number of red blood cells were found. These correlations are not perfect, but decidedly significant in showing a direct reciprocal relationship between the hemoglobin and the number of red blood cells.

6. There was no significant correlation between the hemoglobin of the blood and the number of white blood cells (leucocytes).

7. The hemoglobin determination may be used as a guide in evaluating adaptability of different breeds of cattle to given environmental conditions.

LITERATURE CITED

BROOKS, H. J., AND J. S. HUGHES. 1932. The hemoglobin content of the blood of dairy cattle. Journal of Nutrition 5: 35–38.

BURNETT S. H. 1917. The clinical pathology of the blood. xvi + 166 p., 23 fig., 4 pl. New York: The Macmillan Company.

CARAMBAS, PETRONILO. A comparative study of the growth and development of some pure breed and grade calves. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. 1932. Unpublished.)

GONZALEZ, B. M. 1926. Experience in the Philippines with the introduction of pure breed animals to improve the common stock. Reprinted from the Proceedings of the Third Pan-Pacific Science Congress, Tokyo. p. 1142–1150.

MCCAY, C. M. 1931. The hemoglobin and total phosphorus in the blood of cows and bulls. Jour. Dairy Sci. 14: 373–378.

NEAL, W. M., AND R. B. BECKER. 1933. The hemoglobin content of the blood of healthy and anemic "salt-sick" cattle. Jour. Agric. Res. 46: 557–563.

TABLE 1

Showing the age and breed of animals used

GROUP	NAME OF ANIMAL	H. N.	AGE AT START OF EXPERIMENT		BREED
			Years	Months	
I	Blanca	34	7	10	Nellore
	Ochoa	54	1	7	"
	Juda	56	—	10	"
	Nestor	46	2	10	"
II	Matea	174	6	5	Native
	Nicolasa	198	1	—	"
	Omana	215	—	1	"
	Tomas	158	8	—	"
III	Miss Perfection	4	13	—	Hereford
	Margaret	13	6	10	"
	Mary	17	4	7	"
	Dolly	—	6	9	"
IV	Martin	4	3	4	Holstein
	Deboer	3	3	4	"
	Ford	5	—	9	"
	Curan	8	—	2	"
	Esther	2	5	—	"
V	Venus	57	11	7	Nellore-Native
	Independence	58	11	4	" "
	Aladdin	97	11	—	" "
	Rafael	168	2	2	" "
VI	Aramis	115	5	8	Nellore-Hereford
	Rose	170	2	—	" "
	Raul	171	2	—	" "
VII	Georgia	190	1	3	Nellore-Holstein
	Sophie	193	1	2	" "
	Gordon	191	1	3	" "
	Peter	165	2	3	" "
	Dalid	217	—	9	" "
VIII	Antonio	94	7	5	Native-Hereford
	New Year	87	7	10	" "
	Banquo	136	4	—	" "
	Don Miguel	148	3	3	High grade Hereford
	Mabel	221	—	1	" " "

TABLE 2

Showing the amount of hemoglobin per 100 ml. of blood in the different breeds of cattle examined

BREED	HGB. PER 100 ML. OF BLOOD	COMPARISON					
		Native		Nellore		Hereford	
		Diff.	D/E	Diff.	D/E	Diff.	D/E
	grams	*grams*	*times*	*grams*	*times*	*grams*	*times*
Native	9.43 ± 0.13	—	—	—	—	—	—
Nellore	9.87 ± 0.09	0.44 ± 0.16	2.78	—	—	—	—
Hereford	6.76 ± 0.11	2.66 ± 0.17	15.69	3.11 ± 0.14	22.23	—	—
Holstein	8.28 ± 0.17	1.14 ± 0.21	5.47	1.59 ± 0.19	8.39	1.51 ± 0.13	11.67

TABLE 3

Showing the hemoglobin content of blood in animals of different ages

ANIMAL	HGB. PER 100 ML. OF BLOOD	AGE AT BEGINNING OF EXPERIMENT		BREED
		Years	Months	
	grams			
Juda	10.00 ± 0.11	—	10	Nellore
Ochoa	10.66 ± 0.16	1	1	"
Nestor	9.05 ± 0.20	2	10	"
Blanca	9.77 ± 0.13	7	10	"
Omana	9.39 ± 0.24	—	1	Native
Nicolasa	9.61 ± 0.23	1	—	"
Matea	8.94 ± 0.20	6	5	"
Tomas	9.77 ± 0.31	8	—	"
Curan	7.00 ± 0.16	—	2	Holstein
Ford	6.38 ± 0.13	—	9	"
Martin	10.22 ± 0.09	3	4	"
Deboer	9.92 ± 0.21	3	4	"
Mary	7.66 ± 0.14	4	7	Hereford
Dolly	4.94 ± 0.83	6	9	"
Margaret	6.66 ± 0.10	6	10	"
Miss Perfection	7.77 ± 0.14	13	—	"

TABLE 4

Showing the hemoglobin of animals in "good" and in "poor" condition

ANIMAL	HGB. PER 100 ML. OF BLOOD	CONDITION	BREED
	grams		
Mary	7.66 ± 0.14	good	Hereford
Dolly	4.94 ± 0.83	poor	"
Martin	10.22 ± 0.09	good	Holstein
Ford	6.38 ± 0.13	poor	"

TABLE 5

The hemoglobin in cows before and after calving and the average hemoglobin for the whole period

ANIMAL	HGB. BEFORE CALVING	HGB. AFTER CALVING	AV. HGB. FOR THE PERIOD	BREED
	grams	*grams*	*grams*	
Matea	9.5	11.0	9.94	Native
Nicolasa	9.0	8.5	10.00	"
Blanca	9.5	10.5	10.30	Nellore
Ochoa	9.5	—	11.17	"
Miss Perfection.	—	9.0	8.28	Hereford
Miss Perfection.	8.0	7.7	8.28	"
Mary	9.0	8.5	8.17	"
Independence ..	9.25	8.5	9.11	Nellore-Native
Rose	9.0	9.0	9.77	Nellore-Hereford
Georgia	9.3	9.5	9.59	Nellore-Holstein

TABLE 6

Showing the coefficients of correlation between the hemoglobin indices and the red blood cells

BREED	CORRELATION COEFFICIENTS	COR./P. E.
Native	0.666 ± 0.044	15.05
Nellore	0.720 ± 0.038	18.82
Holstein	0.525 ± 0.065	7.98
Hereford	0.731 ± 0.036	19.83
Nellore-Holstein	0.678 ± 0.043	15.69
Nellore-Hereford	0.723 ± 0.043	16.55
Nellore-Native	0.542 ± 0.056	9.65
Native-Hereford	0.723 ± 0.049	14.57

TABLE 7

Showing the coefficients of correlation between the percentage hemoglobin and the white blood cells

BREED	CORRELATION COEFFICIENTS	COR./P. E.
Native	0.282 ± 0.073	3.85
Nellore	0.199 ± 0.076	2.61
Holstein	0.016 ± 0.090	1.79
Hereford	0.464 ± 0.062	7.44
Nellore-Holstein	0.011 ± 0.080	0.14
Nellore-Hereford	0.135 ± 0.090	1.50
Nellore-Native	0.081 ± 0.078	1.02
Hereford-Native	0.018 ± 0.104	0.17

TABLE 8

Showing the amount of hemoglobin per 100 ml. of blood in the different cross-breed animals examined

BREED	HGB. PER 100 ML. OF BLOOD	COMPARISON			
		Native		Nellore	
		Diff.	D/E	Diff.	D/E
	grams	*grams*	*times*	*grams*	*times*
Nellore-Native ...	9.65 ± 0.20	0.22 ± 0.24	0.91	0.225 ± 0.22	1.02
Nellore-Hereford .	8.94 ± 0.13	0.49 ± 0.19	2.57	0.935 ± 0.16	5.84
Nellore-Holstein .	8.96 ± 0.09	0.47 ± 0.16	2.93	0.915 ± 0.13	7.04
Native-Hereford .	8.85 ± 0.13	0.58 ± 0.18	3.22	1.025 ± 0.16	6.40

TABLE 9

Showing the correlation of results obtained by the Talqvist and Newcomer methods

BREED	CORRELATION COEFFICIENTS	COR./P. E
Native	0.611 ± 0.049	12.28
Nellore	0.282 ± 0.016	17.32
Holstein	0.608 ± 0.057	10.63
Hereford	0.717 ± 0.038	18.58
Nellore-Holstein	0.476 ± 0.061	7.71
Nellore-Hereford	0.545 ± 0.064	8.45
Nellore-Native	0.544 ± 0.055	9.72
Native-Hereford	0.739 ± 0.047	15.67

TREATMENT OF SEEDS AND PLANT CUTTINGS WITH COAL TAR-KEROSENE EMULSION AS A PROTECTION AGAINST CERTAIN INSECTS [1]

VICTORIANO J. MADRID

INTRODUCTION

In the Philippines, certain species of ants cause a great deal of damage to seeds before germination, if the seed beds are not properly constructed. In order to minimize their attack, the common practice is to build boxes or framework with legs that can be set in shallow pans of water and mineral oil. The practice is necessarily a laborious one; likewise, seeds of certain crops have to be planted direct in the field and, therefore, cannot be started in a seed bed.

While ants are a serious menace to seeds, termites injure vegetable cuttings that come in contact with the soil. The present work is an effort to find a practical means of reducing ant and termite infestation either in seed bed or in the field.

Review of literature on the subject

Snyder (1924) found in his experiments on methods of protecting woods against termites, or "white ants" that coal tar-creosote was the most effective reagent in rendering timber resistant for from two to twenty-five years, depending on the length and completeness of treatment.

Jensen (1909) in his work on repellent substances on animal wounds found that coal tar mixed with carbon bisulphide showed one important advantage over the others, in that it adheres to moist surfaces and so forms a coating over raw flesh and thus protects it from screw-worm invasion.

Uichanco (1931) states that after excising the dead tissues of mango trunks and limbs resulting from the work of the mango bark borer (*Plocaederus ruficornis* Newm.), and painting the whole trunk, including the wounds, with a one-to-five dilution of coal tar-kerosene emulsion, reinfestation was checked for at least one year. He further found that immersion of plant cuttings for a short time

[1] Experiment Station Contribution No. 987.

Special problem in Entomology 99 prepared in the Department of Entomology under the direction of Professor Leopoldo B. Uichanco. Received for publication January 17, 1934.

a one-to-ten dilution of the emulsion prevented damage from termites and apparently did not affect germination.

Uichanco (1930) reported that the practice of corralling the grubs of *Leucopholis irrorata* Chevrolat in a coal tar-kerosene emulsion-treated trench (1:5 dilution) at the time of first sign of grub infestation in the sugar cane field gave an absolute control.

Woodworth and Ashcraft (1923) claim that after applying chloroform pack on the foot of an animal infected with foot-maggots (*Booponus intonsus* Aldrich) for 24 hours and following this treatment with a daily application of tar ointment, new infection was prevented.

Objects of the present study

The objects of the present work were: (*a*) to determine viability of seeds after soaking in coal tar-kerosene emulsion for varying lengths of time; (*b*) to determine whether the treatment provides sufficient protection against ants in seed bed; (*c*) to determine viability of cuttings when treated with emulsion; and (*d*) to determine if treatment protects cuttings from termite attack in the ground.

Time and place of the present study

Germination tests of seeds were conducted in both the entomological laboratory and the College grounds where ants' nests were abundant. Germination tests for the cuttings were carried on near the bamboo clumps near the lower nursery of the Department of Agronomy. The work covered about ten months, from November, 1930, to August, 1931.

MATERIALS AND METHODS

Materials

Coal tar-kerosene emulsion. One part of the stock solution of coal tar-kerosene emulsion, prepared according to the method described by Uichanco (1931), was diluted with water to ten parts by volume.[2] The same ratio was used for both seeds and cuttings.

[2] The formula, as given by Uichanco, is as follows:

Stock solution

Laundry soap	500 grams
Coal tar, or "alquitran" (without creosote)	5 liters
Kerosene	3 liters
Water	4 liters

Shave soap into water and boil until dissolved. Remove mixture from fire, and, while still hot gradually add to it kerosene and coal tar which have been mixed in a separate container. As this mixture is added, beat briskly with a small branch with many twigs until a fairly complete emulsion is formed.

Seeds. The most common vegetable seeds, such as tobacco, radish, pechay (*Brassica cernua* [Thunb.] Forbes and Hemsl.), mustard (*Brassica integrifolia* [West] O. E. Schulz), cabbage, papaya (*Carica papaya* Linn.) and Chili pepper (*Capsicum frutescens* Linn.) were tested.

Cuttings. The cuttings tested were mulberry (*Morus alba* Linn.), morado (*Gratophyllum pictum* [Linn.] Griff.), acalypha (*Acalypha wilkesiana* Muell-Arg.), papua (*Nothopanax fruticosum* [Linn.] Miq.) San Francisco (*Codiaeum variegatum* [Linn.] Blume), and gumamela (*Hibiscus rosa-sinensis* [Linn.] Miq.). Siniguelas (*Spondias purpurea* Linn.) and malungay (*Moringa oleifera* Lam.) were also tried but there were not enough good cuttings for satisfactory results. A siniguelas branch from which three to six cuttings could be prepared cost from ₱0.70 to ₱1.20. Not only was the price high, but the owners were reluctant to prune their trees.

Methods

Preparation of cuttings. To minimize so far as possible variability in germination in the different lots due to differences in the physical and physiological conditions of the cuttings, they were sorted into three groups for each plant species tested, as A, B, and C, in such a way that every cutting in group A had a counterpart in each of the other two groups, B and C, in length, size, age, and the like. For practical purposes, the tenderness of the tissues and amount of bloom present on the surface were used as criteria in determining the age of the cuttings. The same procedure was followed throughout the experiments.

For the seeds, roguing was first performed, and the remaining seeds which were now nearly all sound were divided into three groups.

Soaking the seeds in the solution and draining on cloth. One lot of the seeds prepared as above was soaked in 1:10 coal tar-kerosene emulsion for one hour and another lot just long enough to wet all the seeds uniformly. To insure uniform wetting of the seeds the mixture was gently stirred as soon as the seeds were immersed, and at frequent intervals for the one-hour immersion. The third lot received no treatment. The soaked seeds were drained on cheese cloth. They were sown in seed boxes made of petroleum cases which had been cut into halves lengthwise. The seeds stuck together while wet but mixing them with about five times their volume of fine dust made sowing much easier and fairly uniform. The same procedure of sowing was followed for the control.

Ordinary garden soil was used. A sufficient quantity was piled under the Hawaiian Sugar Planters' Insectary and then pulverized well. It was then shoveled back and forth several times in such a way as to put that at the bottom or at the middle on top and that on top at the middle or bottom. This was done to make the soil condition in all the boxes as uniform as possible, as differences might affect germination.

After sowing, side by side, the seeds, the boxes containing the treated and the control seeds were labeled and then exposed to ants' nests. Another series was put in the insectary from which ants and other outward factors that might affect germination were excluded. In this test, instead of seed boxes the rag-doll method and Petri dishes half-filled with soil were used as germination media. The seed beds were watered at frequent intervals until complete germination was attained. After the seeds had fully germinated, as judged by some of the seedlings being about two centimeters high, the number that germinated was determined by pulling them out one by one.

Cuttings. The plant cuttings were treated in the same manner as the seeds. The cuttings were immersed two-thirds or more from the base, never the whole length. They were then planted 5 × 5 cm. apart in rows in prepared plots. The treated and the untreated, or check, were planted adjacently. The cuttings were watered from time to time until they fully germinated. They were closely observed until the young plants became fully established. In the course of inspection, those that showed signs of shrinkage before germination and those that showed wilting of buds or leaves in the course of germination were examined by carefully removing the soil until the base was exposed to view. After examination, the soil was returned.

DISCUSSION OF RESULTS

The results of these experiments are shown in tables 1, 2, and 3. Table 1 shows the germination of treated and untreated seeds kept in the insectary from which ants were excluded; table 2, the germination of seeds treated as in table 1 but exposed to ants' nests; and table 3, the germination of treated and untreated plant cuttings.

It may be seen in table 2 that there is a great difference in germination of the treated and the untreated, or check, lots, the much higher germination being in the treated seeds. The difference between the short and the one-hour immersion lots was very slight, indicating that prolonged treatment, up to one hour was not particularly harmful to the seeds.

When the material was exposed to ants, the very much higher percentage germination of treated seeds as compared with the control would indicate that coal tar-kerosene emulsion treatment positively protects against these pests. The writer observed that three to six hours after exposure, the ants began to attack the untreated, or check, seeds either by carrying them away or by eating them on the spot.

Ants began to visit the treated seeds three days after exposure but they did no appreciable damage. Comparing tables 1 and 2, it may be seen that ants affected somewhat the treated seeds as indicated by the slight difference in the percentage of germination between those kept inside the insectary and those exposed to ants. This difference, however, is of little consequence ranging from only 0 to 1 per cent.

In relation to termite damage, conditions and results similar to that of the seeds were observed in the plant cuttings (table 3). Treated cuttings showed a much higher percentage of germination than the control. Prolonged treatment, that is, one hour, when compared with short immersion, reduced germination somewhat, but very little when compared with that of the untreated cuttings.

Unlike the seeds, initial infestation, or attack on the cuttings could not be ascertained. This was because the termites made their way below the surface and attacked the portions under the ground. Hence, attack could only be determined by digging and removing some of the soil around the base of a cutting whose appearance was suspicious looking. When a cutting began to show signs of shrinkage before germination or when the buds formed in the process of germination showed abnormalities, the base was examined. The writer concluded that infestation of the untreated cuttings began about three weeks after planting and continued until the plants had established a more or less permanent growth. The treated lots enjoyed very much longer immunity. Only a few of the cuttings that died in these lots showed signs of attack. It was suspected that the attack was more or less secondary, that is, the cuttings were eaten by termites subsequent to death. The untreated cuttings that showed signs of attack were fairly fresh at the beginning of infestation.

SUMMARY AND CONCLUSIONS

1. Because of their destruction of seeds, ants are serious pests in seed beds.

2. Termites, or white ants, attack most woods that come in contact with the ground, plant cuttings before germination, and occasionally growing crops.

3. Immersing seeds in 1:10 solution of coal tar-kerosene emulsion from a few minutes to one hour provides an adequate protection against ants. The same treatment of plant cuttings keeps them free from termite damage in the soil.

4. Immersion of seeds and plant cuttings in a 1:10 solution of coal tar-kerosene emulsion from a few minutes to one hour does not materially affect viability.

5. Initial infestation in the untreated lots of plant cuttings began about three weeks after planting, while the cuttings were still fresh, and continued until the plants had more or less established growth. The treated cuttings enjoyed a very much longer period of immunity, and whatever attack developed later was apparently subsequent to death.

6. Initial infestation of untreated seeds began in from three to six hours after exposure to ants; in the treated seeds, ants began to come three days later, but without causing injury.

LITERATURE CITED

JENSEN, H. 1909. [Fly repellents]. In Missouri Valley Vet. Bull. 4: 30–31. Notes by editor. *Cited in* U. S. Dept. Agric. Bull. 131: 1–26.

SNYDER, THOMAS E. 1924. Tests of methods of protecting woods against termites, or white ants. A progress report. U. S. Dept. Agric. Bull. 1231: 1–16. *Fig. 1–3; pl. 1–2.*

UICHANCO, L. B. 1930. A report on an entomological survey of Negros sugar cane fields, March, 1930. Sugar News 11: 243–254.

UICHANCO, L. B. 1931. Coal tar-kerosene emulsion and its uses as an insecticide. The Philippine Agriculturist **19**: 501–505.

WOODWORTH, H. E., AND J. B. ASHCRAFT. 1923. The foot maggot, *Booponus intonsus* Aldrich, a new myiasis-producing fly. Philippine Jour. Sci. **22**: 143–156. *Pl. 1–8.*

TABLE 1

Germination of treated and untreated seeds inside insectary; ants excluded

NAME OF SEEDS USED	TREATMENT	NUMBER OF SEEDS TREATED	NUMBER OF SEEDS GERMINATED	GERMINATION
				per cent
Tobacco (*Nicotiana tabacum* Linn.)	Short immersion	300	208	69.33
	1 hour "	300	205	68.33
	Control (not treated)	300	210	70.00
Radish (*Raphanus sativus* Linn.)	Short immersion	300	204	68.00
	1 hour "	300	201	67.00
	Control (not treated)	300	210	70.00
Pechay (*Brassica cernua* [Thunb.] Forbes et Hemsl.)	Short immersion	300	231	77.00
	1 hour "	300	226	75.33
	Control (not treated)	300	238	79.33
Mustard (*Brassica integrifolia* [West] O. E. Schultz.)	Short immersion	300	239	79.67
	1 hour "	300	235	78.33
	Control (not treated)	300	241	80.33
Cabbage (*Brassica oleracea* Linn.)	Short immersion	300	226	75.33
	1 hour "	300	217	72.33
	Control (not treated)	300	230	76.67
Papaya (*Carica papaya* Linn.)	Short immersion	300	218	72.33
	1 hour "	300	212	70.67
	Control (not treated)	300	220	73.33
Chile pepper (*Capsicum frutescens* Linn.)	Short immersion	300	241	80.33
	1 hour "	300	237	79.00
	Control (not treated)	300	248	82.67

TABLE 2

Germination of treated and untreated seeds exposed to ants' nests

NAME OF SEEDS USED	TREATMENT	NUMBER OF SEEDS TREATED	NUMBER OF SEEDS GERMINATED	GERMINATED
				per cent
Tobacco (*Nicotiana tabacum* Linn.)	Short immersion	1500	1029	68.60
	1 hour "	1500	1006	67.06
	Control (not treated)	1500	84	5.60
Radish (*Raphanus sativus* Linn.)	Short immersion	1100	747	67.91
	1 hour "	1100	728	66.18
	Control (not treated)	1100	124	11.27
Pechay (*Brassica cernua* [Thunb.] Forbes et Hemsl.)	Short immersion	1300	998	76.77
	1 hour "	1300	976	75.08
	Control (not treated)	1300	173	13.31
Mustard (*Brassica integrifolia* [West] O. E. Schultz.)	Short immersion	1300	1027	78.92
	1 hour "	1300	1010	77.69
	Control (not treated)	1300	172	13.30
Cabbage (*Brassica oleracea* Linn.)	Short immersion	1100	823	74.82
	1 hour "	1100	790	71.82
	Control (not treated)	1100	148	13.45
Papaya (*Carica papaya* Linn.)	Short immersion	1500	1070	71.33
	1 hour "	1500	1051	70.07
	Control (not treated)	1500	428	28.53
Chile pepper (*Capsicum frutescens* Linn.)	Short immersion	950	759	79.89
	1 hour "	950	756	79.58
	Control (not treated)	950	53	5.58

TABLE 3

Germination of treated and untreated plant cuttings

NAME OF CUTTINGS USED	TREATMENT	NUMBER OF CUTTINGS USED	NUMBER OF CUTTINGS GERMINATED	GERMINATION
				per cent
Mulberry (*Morus alba* Linn.)	Short immersion	340	261	76.76
	1 hour "	340	252	74.12
	Control (not treated)	340	195	57.35
Acalypha (*Acalypha wilkesiana* Muell-Arg.)	Short immersion	380	320	84.21
	1 hour "	380	318	83.68
	Control (not treated)	380	259	68.16
Papua (*Nothopanax fruticosum* [Linn.] Miq.)	Short immersion	428	371	86.82
	1 hour "	428	368	86.21
	Control (not treated)	428	278	64.95
San Francisco (*Codiaeum variegatum* [Linn.] Blume)	Short immersion	380	337	88.68
	1 hour "	380	334	87.11
	Control (not treated)	380	253	66.58
Gumamela (*Hibiscus rosa-sinensis* [Linn.] Miq.)	Short immersion	380	334	87.89
	1 hour "	380	317	83.89
	Control (not treated)	380	229	65.53
Morado (*Graptophyllum pictum* [Linn.] Griff.)	Short immersion	380	280	73.68
	1 hour "	380	277	72.88
	Control (not treated)	380	206	54.21

EFFECTS OF FERTILIZERS ON THE GROWTH AND DEVELOPMENT OF YOUNG LANZON PLANTS (LANSIUM DOMESTICUM CORREA)[1]

CORNELIO O. MARIANO

WITH FIVE TEXT FIGURES

The lanzon plant (*Lansium domesticum* Correa), which produces the "crown prince of Philippine fruits"[2]—a fruit so valuable that "it's worth its weight in gold almost,"[3] is a rather slow grower. According to lanzon growers in Paete, Laguna, the best known lanzon region in the country, the tree does not bear fruit until twelve to fifteen years old. Obviously, it is desirable that ways and means be found to hasten the growth and development and the fruiting of this plant. Among the possible methods of accomplishing this end may be mentioned the selection of the early fruiting types or individuals from which propagating materials may be secured; proper cultural methods, such as, cultivation and the care of the plantation; and the application of fertilizers and manures.

The object of the study reported in this paper was to find fertilizers or combinations of fertilizers that would promote a more rapid growth and development of young lanzon plants.

The work was conducted in the Experimental Garden of the Department of Plant Physiology of the College of Agriculture, from October, 1931 to January, 1933.

MATERIALS

The young lanzon plants

The young lanzon plants that were used in this study were raised from two lots of seeds which were obtained from a tree in Manaol, Laguna. One lot consisted of about five hundred seeds of about the same size. To hasten germination, the coats of these seeds were removed before they were planted, all at the same time, in a nursery

---

[1] Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture, from the College of Agriculture No. 432; Experiment Station contribution No. 988. Prepared in the Department of Plant Physiology under the direction of Dr. Rafael B. Espino.

[2], [3] Exhibit labels in horticultural exposition, at Philippine Carnival, 1932.

in Manaol, Laguna. Most of the seeds germinated; and young plants of apparently uniform development were selected and brought to the College and used in experiments 1, 2, 3, and 4.

The other lot also consisted of about five hundred seeds. These seeds, after removing the seed coats, were sown in germinating boxes containing sterilized sand in the Experimental Garden of the Department of Plant Physiology. A rather higher percentage of germination was obtained than with the first lot. When sufficiently tall, young plants of about the same size were selected and planted in pots containing either clay-loam soil, or tuff soil, one plant to each pot, and were used in experiments 5, 6, and 7.

The soil media

The two types of soil media used were tuff soil and clay-loam soil. They were used separately and were taken from two distinct sources on the College Campus. The soil was pulverized, cleaned, and thoroughly mixed. In each earthen pot used, six kilograms of soil were placed; this was used as the solid culture media in this study. Analyses of samples of the types of soil were made by the Department of Chemistry, College of Agriculture. The results show that the tuff soil contained 0.11 per cent N, 0.36 per cent P_2O_5, and 0.42 per cent K_2O; the clay-loam soil contained 0.31 per cent N, 0.48 per cent P_2O_5, and 0.92 per cent K_2O.

The cultures and experimental data obtained

Seven sets of cultures divided into two parts were tried in this study, the first part consisted of five sets of cultures supplied with the tuff soil in pots, and the second part consisted of two sets of cultures supplied with clay-loam soil in pots. Each set of cultures is considered as an experiment in this paper.

CULTURES AND RESULTS

Cultures in tuff soil

Experiment 1. To determine the relative nutritive values to young lanzon plants of the Corona Cocos fertilizer when added in different amount to tuff soil in pots. This experiment consisted of six 5-replicated cultures to which Corona Cocos fertilizer was added in different amounts. The N-P-K or the N-P_2O_5-K_2O contents of the fertilizer in the different cultures were computed and the

data obtained are given in table 1. The experimental data obtained under the different criteria of results such as (*a*) total increase in height of plants, (*b*) number of leaves at harvest, (*c*) increase in number of leaves, (*d*) fresh weight of leaves, (*e*) fresh weight of stem, (*f*) fresh weight of root, (*g*) fresh weight of whole plant, and (*h*) leaf-product are given in table 1.

Experiment 2. To determine the relative nutritive values to young lanzon plants of Ammo-Phos 13-48 fertilizer when added in different amounts to tuff soil in pots. This experiment consisted of six 5-replicated cultures in which Ammo-Phos 13-48 fertilizer was present in different amounts. For experimental data obtained in this experiment see table 2.

Fig. 1.—Showing effects on the growth and development of young lanzon plants of different commercial fertilizers when added singly in different amounts to tuff soil in pots. Left to right: Corona Cocos *A*, 8.8 grams; *B*, 13.2 grams; *C*, 22.0 grams; *D*, 35.2 grams; *E*, 57.2 grams; and *F*, control (no fertilizer). Ammo-Phos 13-48, *A*, 8.8 grams; *B*, 13.2 grams; *C*, 22.0 grams; *D*, 35.2 grams; *E*, 57.2 grams; and *F*, control (no fertilizer). Sulfate of ammonia, *A*, 8.8 grams; *B*, 22.0 grams; *C*, 57.2 grams; and *D*, control (no fertilizer). Photographed when about 11 months old.

Experiment 3. To determine the relative nutritive values to young lanzon plants of sulfate of ammonia fertilizer when added in different amounts to tuff soil in pots. This experiment consisted of four triplicate cultures in which sulfate of ammonia fertilizer was present in different amounts.

For experimental data obtained in this experiment see table 3. For appearance of plants in experiments 1, 2, 3 when 11 months old see figure 1.

Experiment 4. To determine the comparative nutritive values to young lanzon plants of different fertilizers when added alone or in certain combinations and in different amounts to tuff soil in pots. Eight cultures were started with five replications each. The cultures received different fertilizers applied either singly or in certain combinations, except one culture which served as control and received no fertilizer. For the experimental data in this experiment see table 4. For appearance of plants when 11 months old see figure 2.

Experiment 5. To determine the comparative effects on the growth and development of young lanzon plants of commercial fertilizers, nitrate of potash, Ammo-Phos 13–48, and sulfate of ammonia which were added singly and in different amounts to tuff soil in pots. This experiment consisted of sixteen triplicate cultures to which each of the commercial fertilizers was applied in different amounts. The data on this experiment are shown in table 5. For appearance of plants when 7 months old see figure 3.

Fig. 2.—Showing effects on the growth and development of young lanzon plants of different fertilizers when added singly or in certain combinations to tuff soil in pots. From left to right: *A*, 13.2 grams sulfate of ammonia; *B*, 13.2 grams sulfate of ammonia + 30.0 grams horse manure; *C*, 13.2 grams sulfate of ammonia + 13.5 grams superphosphate + 30.0 grams horse manure; *D*, 6.76 grams nitrate of potash; *E*, 6.76 grams nitrate of potash + 30.0 grams horse manure; *F*, 6.76 grams nitrate of potash + 13.5 grams superphosphate + 30.0 grams horse manure; *G*, 13.5 grams superphosphate; and *H*, control (no fertilizers). Photographed when about 11 months old.

Cultures in clay-loam soil

Experiment 6. To determine the relative nutritive values to young lanzon plants of sulfate of ammonia, nitrate of potash, and superphosphate fertilizers when added separately to clay-loam soil

in pots. This experiment consisted of four quadruplicate cultures to which each fertilizer was added at the rate of 7.8 grams per pot. Table 6 shows the experimental data obtained under the different criteria of results. For appearance of plants when about 10 months old see figure 4.

Experiment 7. To determine the comparative nutritive values to young lanzon plants of different fertilizers, when added alone or in certain combinations to clay-loam soil in pots. This experiment consisted of seven 5-replicated cultures to which the fertilizers were added in different amounts. The experimental data obtained under the different criteria of results are shown in table 7. For appearance of plants when 10 months old, see figure 5.

Fig. 3.—Showing effects on the growth and development of young lanzon plants of different commercial fertilizers when added singly to tuff soil in pots. From left to right: Nitrate of potash, *A*, 4.4 grams; *B*, 6.6 grams; *C*, 11.0 grams; *D*, 17.6 grams; *E*, 28.6 grams. Ammo-Phos 13–48, *A*, 4.4 grams; *B*, 6.6 grams; *C*, 11.0 grams; *D*, 17.6 grams; and *E*, 28.6 grams. Sulfate of ammonia, *A*, 4.4 grams; *B*, 6.6 grams; *C*, 11.0 grams; *D*, 17.6 grams; *E*, 28.6 grams; and *F*, control (no fertilizer). Photographed when plants were about 7 months old.

Application of fertilizers

Twice during the experimental period fertilizers were applied to certain sets of cultures. The first application of the fertilizers was at the beginning of each experiment and the second application was six months after the first or at the time when the plants were found to be no longer growing or the growth was very slow. Experiments 5 and 8, which were carried out for only a period of seven months were not given the second application of fertilizers.

Care of cultures

To protect the young lanzon plants from the sun, the cultures were placed under a shelter consisting leaves of coconut spread on

a frame made of bamboo. The cultures were watered when necessary, giving the different cultures the same amount. From time to time, the cultures were weeded and the soil in each pot loosened, care being taken not to destroy or damage the roots.

Weather observations

The following notes will give an idea of the weather conditions that prevailed during the course of this study.

A moderate typhoon occurred on September 14 and 15, 1932, when the experiments 1 to 7 were in progress. Four plants in experiment 5 (see table 5) were destroyed. During the latter part of the study the weather was fair, with frequent clear days.

The rainfall ranged from 4.9 to 431.0 mm.; the minimum was registered in April, 1932, and the maximum in July, 1932. The

Fig. 4.—Showing effects on the growth and development of young lanzon plants of different commercial fertilizers when added alone to clay-loam soil in pots. From left to right: *A*, 7.8 grams sulfate of ammonia; *B*, 7.8 grams nitrate of potash; *C*, 7.8 grams superphosphate; and *D*, control (no fertilizer). Photographed when plants were about 10 months old.

rainfall decreased from 23.4 mm. in January, 1932 to 4.9 mm. in April of the same year. Then it increased to 116.9 mm. in May, 1932 and to 431.0 mm. in July, 1932. From August, 1932, it decreased then increased gradually up to November, 1932, then again decreased slowly to 85.5 mm. in January, 1933, the end of the culture period. It should be stated that the cultures were not dependent upon the rain for supply of water.

The range of temperature recorded was from 29.3°C., the minimum, to 35.4°C., the maximum. The former occurred in January, 1932 and the latter in April, 1932. From January the temperature rose to 35.3°C. in May and during the months from June, 1932 to January, 1932 the temperature fluctuated from 30.2 to 34.5°C.

Results: Criteria

Perhaps the best criterion of results in fertilizer experiments with lanzon plants is the fruit produced, that is, the quality and quantity. But as young plants were used in this study, criteria of results other than the fruits were used. The experimental data under each criterion were gathered as follows:

Total increase in height of plants. The total increase in height of each plant was determined by adding together all the monthly increases in height [4] of the plant. The data thus obtained are reported in tables 1 to 7.

Number of leaves at harvest. At the time of harvest, the leaves of the plant in each culture were counted, and the data thus obtained are recorded in tables 1 to 7.

Fig. 5.—Showing effects on the growth and development of young lanzon plants of different fertilizers when added to clay-loam soil in pots. From left to right: *A*, 7.8 grams, sulfate of ammonia; *B*, 7.8 grams, sulfate of ammonia + 1.9 grams, superphosphate; *C*, 1.9 grams, sulfate of ammonia + 1.9 grams, superphosphate + 1.9 grams, nitrate of potash; *D*, 7.8 grams, sulfate of ammonia + 1.9 grams, horse manure; *E*, 7.9 grams, sulfate of ammonia + 1.9 grams, superphosphate + 1.9 grams, horse manure; *F*, 7.8 grams, superphosphate; and *G*, control (no fertilizer). Photographed when plants were about 10 months old.

Increase in number of leaves. The data under this criterion were obtained by subtracting the initial number of the *simple* leaves of the plant from the number of the *simple* leaves of the same plant at the time of harvest. Then, the compound leaves of the plant in each culture were counted, and the data obtained together with the data on the number of simple leaves are given in tables 1 to 7. In no culture were there plants that had compound leaves at the beginning of the experiment.

[4] The original data on monthly increases in height are on file in the Department of Plant Physiology.

Fresh weight of top. At the time of harvest, the top of the plant in each culture was severed from the root system by cutting it off at the base of the stem. Then the weight of the top while fresh was determined on a Cenco balance.

Fresh weight of stem. Soon after having determined the fresh weight of the top, all the leaves were detached from the stem. The stem was then weighed on a Cenco balance. The results constitute the data on *fresh weight of stem.*

Fresh weight of leaves. The weight of the stem obtained from one culture was subtracted from the weight of top obtained from the same culture. The difference constitutes data cn the *fresh weight of the leaves* of that plant.

Fresh weight of root. After the data on the aërial parts of the plants had been found the roots from each culture were collected and thoroughly washed with water, care being taken that no roots were lost in the washing. Then the mass of roots obtained from the different *cultures in a set,* were gently wiped one by one with a piece of clean cheese cloth. Then, the mass of roots from the different cultures were separately weighed on a Cenco balance, and the weights obtained constitute the data on fresh *weight of roots.*

Fresh weight of plant. The data under this criterion were obtained by adding the weight of the top and the weight of the roots of the plant obtained from each culture.

Leaf-product of plant. The term "leaf-product" is a rough estimate of the area of a leaf-blade. The data under the criterion were determined by multiplying the length by the width of each leaf blade. Then, the "leaf-products" of all the leaf blades of a plant were added together; the sum constituted the "leaf-product" of that plant. If compound leaves were found on the same plant, their leaf product was also determined. The "leaf--product" of each of the leaflets of a compound leaf was secured and added together. The result constituted the "leaf-product" of that compound leaf. Then, the leaf-product of the simple leaves and of the compound leaf or leaves from the same plant were added together, and the sum constituted the "leaf-product" of that plant.

DISCUSSION OF RESULTS

As stated elsewhere in this paper the best criterion of results of fertilizer studies with lanzon plant is the amount and the quality of fruits produced. But as the plant is a relatively slow grower it could not be brought to its fruiting stage in the limited period given to this study. It is an accepted belief, however, that vigor

of a plant when young favorably influences the later life of that plant. Consequently, the data gathered in this study are of value in suggesting how the plant may be improved.

Because of the rather wide scope of the problem covered, this study should be considered only as an experimental survey that might lead to the discovery of the fertilizers or combinations of fertilizers that should be further tried with young lanzon plants, and incidentally to the discovery of the fertilizers, combinations of fertilizers or combinations of fertilizer ingredients (or critical elements) which show promise of being beneficial to young lanzon plants.

Cultures in tuff soil

Nutritive value of Corona Cocos to young lanzon plants. As shown in figure 1 and in table 1 and 2, the best culture in the Corona Cocos lot was not any better than the poorest culture in the Ammo-Phos 13–48 lot. It appears, therefore, that the Corona Cocos in amounts so far tried was not especially suitable for young lanzon plants. Moreover, culture IV which received 35.2 grams of Corona Cocos in two applications gave better results under the fresh weights of the plants and plant parts than culture V, which received 57.2 grams of the fertilizer. Therefore, the apparent inferiority of Corona Cocos to Ammo-Phos 13–48 when supplied to young lanzon plants was due not to insufficient amounts of Corona Cocos applied but to the fertilizer itself. However, as shown in table 1, most of the cultures that received Corona Cocos produced better results under most of the criteria than those obtained from the control or the unfertilized culture. In fact, under the criterion of fresh weight of the whole plant, culture IV was 98 per cent better than the control culture. Culture IV received 2.11 grams N, 1.23 grams P, and 2.63 grams K from Corona Cocos. This same culture medium received 2.11 grams N, 2.92 grams P_2O_5, and 2.17 grams K_2O from the same fertilizer. But, when the N-P_2O_5-K_2O contents of the soil in the pot were combined with the N-P_2O_5-K_2O contents of the fertilizer, culture IV contained 8.71 grams N, 24.42 grams P_2O_5, and 28.37 grams K_2O.

Nutritive values of Ammo-Phos 13-48 to young lanzon plants. As shown in figure 1 and by the data in table 2, Ammo-Phos 13–48 when added to tuff soil in pots at the rates ranging from 8.8 to 57.2 grams was beneficial to young lanzon plants. Each of the fertilized cultures produced better developed plants than the control, or the non-fertilized culture. In term of the fresh weight of the plants the fertilized cultures were from 260 to 650 per cent better than the unfertilized.

Comparing the nutritive merits of the different applications of Ammo-Phos 13–48, it may be seen in table 2 that cultures IV and V gave the highest data under most of the criteria of results. These two cultures may, therefore, be considered as the most promising for young lanzon plants. Culture V was decidedly a better culture than culture IV. And, in term of fresh weight of plants, culture V which received 57.2 grams of Ammo-Phos 13–48 in two applications was found to be about 650 per cent better than the control culture (see table 2). The 57.2 grams of Ammo-Phos 13–48 supplied young lanzon plants with 6.12 grams N and 27.46 grams P_2O_5 (or 11.97 grams P). And, when these fertilizer ingredients are combined with those supplied by the tuff soil, the most promising culture medium for the young lanzon plant was found to contain 12.72 grams N, 49.06 grams P_2O_5 (or 21.39 grams P) and 25.2 grams K_2O. But, the best culture medium in the Ammo-Phos 13–48 lot contained the largest dose of the fertilizer. Future culture tests should, therefore, contain this fertilizer at a rate around 57.2 grams or more per plant when grown in tuff soil in pots.

Ammo-Phos 13–48 was again tried on young lanzon plants grown in tuff soil in pots. Unfortunately, the data obtained (table 5 and fig. 3) were for younger plants, only seven months old, and the amount of Ammo-Phos 13–48 applied to each culture was only one-half of that applied to the corresponding culture in the previous experiment (see table 2). But the suitability of Ammo-Phos 13–48 as a fertilizer for young lanzon plants when grown in tuff soil in pots is again shown. The yields, under most of the criteria of results employed, obtained from the set of cultures supplied with Ammo-Phos 13–48 were as a whole greater than those obtained from the set of cultures supplied with sulfate of ammonia. Moreover, as shown in table 5 and in figure 3, Ammo-Phos 13–48 was also nutritively superior to nitrate of potash when used as fertilizer for young lanzon plants grown in tuff soil in pots.

Nutritive values of sulfate of ammonia to young lanzon plants. As shown in figure 1 and the data given in table 3, cultures I, II, and III, that is, all the cultures that received sulfate of ammonia fertilizer in two applications in amounts ranging from 8.8 to 57.2 grams per culture were better than the control culture, which received no fertilizer. Of the three fertilized cultures tried, and under most of the criteria of results employed, culture I was found to be better than culture II, and culture II better than culture III. Since culture I received 8.8 grams of the fertilizer, culture II, 22 grams; and culture III, 57.2 grams, it appears that the beneficial effects of

the fertilizer on the young lanzon plants were in inverse order to the amount of the fertilizer used, that is, the cultures receiving the least amount of fertilizer gave the best results.

Under the criterion of *fresh weight of the whole plant,* culture I was 115 per cent better than the control culture. This best culture medium in this lot received 1.492 grams N from sulfate of ammonia. When the N-P_2O_5-K_2O contents of the soil in pot were combined with the nitrogen content of the fertilizer, culture I was found to contain 8.092 grams N, 21.6 grams P_2O_5, and 25.2 grams K_2O.

While most of the data in table 3 show the beneficial effects upon the young lanzon plants when supplied with sulfate of ammonia, the data under the criterion of *fresh weight of leaves* supported by the appearance of the plants as shown in figure 1, clearly show that the plants in cultures II and III in production of leaves gave a rather poor response to the fertilizer. This result seems to indicate either that the fertilizer was not very suitable to the plants or that the amounts applied were too much. The fact that culture I, which received the smallest amount of sulfate of ammonia, produced the best developed plant in the lot lends some support to the latter supposition, and suggests that in future trials this fertilizer should be tried in amounts smaller than the amounts here tested.

Sulfate of ammonia was again tried on young lanzon plants grown in tuff soil in pots. The experimental data obtained recorded in table 5 and the cultures in figure 3, show that better results were obtained this time. This set of cultures was run for seven months only so that the plants were younger than in the other sets and received only one application of sulfate of ammonia. Of the cultures tried, cultures II-b and III-b appeared to be the best. These two cultures received 6.6 grams and 11.0 grams of sulfate of ammonia, respectively. When compared with the control culture under the criterion of *fresh weight* of the whole plant, these two best fertilized cultures were found to be 196 and 184 per cent, respectively, better than the control culture.

Again, the data in table 5 show that of the cultures in the ammonia sulfate set and under most of the criteria, culture I-b was inferior to culture II-b, and culture II-b was better than any of the other cultures in the set. In fact, with only a few exceptions, starting from culture II–b, the yields under the criteria of results employed decreased as the amounts of the fertilizer added to the pots were increased. This findings seems to corroborate, in some measure,

the conclusion from the results obtained from the other ammonium sulfate set of cultures that the failure of the young lanzon plants to do well in those cultures was due to the excess use of the fertilizer.

However, it was also suspected from the results of the previous set of cultures in experiment 3 that the apparent poor results obtained from the use of sulfate of ammonia may have been due also to its poor fertilizing value when the plant was grown in tuff soil in pots. This suspicion appears to have foundation in fact as it is apparently supported by the data in table 5 and by the plants shown in figure 3. For, culture I–b which received 4.4 grams of sulfate of ammonia was inferior to culture II–b which was supplied with a little larger amount (6.6 grams) of the fertilizer. Of course, it should be understood that the claim of *unsuitability* of sulfate of ammonia is based only on the better results obtained when another fertilizer, Ammo-Phos 13–48, was used, and does not preclude the conclusion that ammonium sulfate when used at the rates ranging from 4.4 grams to 17.6 grams per pot produced better results under most of the criteria of results employed than those obtained from the control cultures in which the plants were grown in tuff soil only. In fact, as it has already been pointed out, under the criterion of fresh weight of the plants, culture II-b, the best culture in the lot, was found to be 196 per cent better than the control culture.

Culture II-b was supplied with 6.6 grams of sulfate of ammonia and contained 1.12 grams N. The nutrient contents of the fertilizer when added to the nutrient in the soil result in 7.72 grams N; 21.6 grams P_2O_5, and 25.2 grams K_2O.

Nutritive value of certain commercial fertilizers when used singly or in combination with horse manure. For a more nutritive effect, Russell (1926)[5] recommends the addition of sulfate of ammonia to farmyard manure or *vice versa*. Such a recommendation is in some measure supported by the experimental data recorded in table 4 and illustrated in figure 2 in the present study. The two highest yields under each of the criteria of results were arbitrarily selected and indicated in table 4 by Hs. The result shows that, except in one instance, the Hs fall under cultures III and IV. These two cultures may, therefore, be considered as the most promising for young lanzon plants,—following this arbitrary method of selection. And, except culture II, and under most of the criteria each of the other fertilized cultures were better than culture VIII, which received no fertilizer application. Culture II was strikingly poor

---

[5] RUSSELL, J. E. 1926. Plant nutrition and crop production. ix + 115 p., 37 fig. Berkeley, California: University of California Press.

or even harmful to the young lanzon plant. It produced relatively very low yields of roots, stem, and particularly leaves. In fact, cultures I and II which received fertilizer only or principally as sulfate of ammonia produced plants with the least number of leaves. In these cultures, ammonium sulfate was applied in two applications with a total amount of 13.2 grams per plant. The poor development of the foliage-leaves of the plants in the cultures may have been due to an excess amount of the fertilizer used,—a result which seems to confirm similar results obtained in experiment 3 in this study.

However, as shown by the data in table 4, the defoliating effects on the leaves produced by 13.2 grams of sulfate of ammonia when used alone or even when mixed with 30 grams of air-dry horse manure were not only neutralized in culture III when to the same amount of ammonium sulfate fertilizer were added 13.5 grams of superphosphate and 30 grams of air-dry horse manure, but well developed plants, the best in the lot, were obtained from such a mixture. Culture III, the best culture recorded in table 4, under the criterion of *fresh weight* of the whole plant was found to be 338 per cent better than the control culture, which received no fertilizer. Culture III consisted of 4.5 kilograms of tuff soil to which were added in two applications, 13.2 grams of sulfate of ammonia, 13.5 grams of superphosphate, and 30 grams of air-dry horse manure. This fertilizer mixture supplied the young lanzon plants with 2.386 grams N, 1.094 grams P, and 0.123 grams K; or it supplied the culture with 2.386 grams N, 2.508 grams P_2O_5, and 0.144 grams K_2O. When the N-P_2O_5-K_2O contents of the tuff soil in pots were included, the total nutrient contents of culture III, the best culture, were found to be 7.336 grams N, 18.708 grams P_2O_5, and 19.044 grams K_2O.

Further study of the contents of table 4 shows that although culture IV was next best in the lot, the yields obtained under most of the criteria were only about 40 or 50 per cent as much as the corresponding data obtained from the best culture, (culture III) and by a rough estimate, only a little over 100 per cent better than the control culture. The second best culture (culture IV) which received 6.76 grams of nitrate of potash should, therefore, be considered not exceptionally suitable for young lanzon plants. And, as shown by the data in table 4, no apparent improvement of the plants or of the yields were obtained even when horse manure, or horse manure and superphosphate were added to the nitrate of potash (see cultures V and VI). Culture VII which received 13.5 grams of superphosphate produced better results than the unfertilized cul-

ture. But the difference of 57 per cent was so little that it does not seem justifiable to consider culture VII as a really good culture medium for young lanzon plants.

Nutritive values of nitrate of potash to young lanzon plants. As shown in figure 3 and by the data given in table 5, all the cultures in the nitrate of potash lot were inferior to the cultures found in either the Ammo-Phos 13–48 lot or the sulfate of ammonia lot. In fact, out of the four fertilized cultures tried, supplied with nitrate of potash, two cultures produced lower yields under most of the criteria than the control culture. And the two other fertilized cultures, although they produced better results under the same criteria than the control culture, the difference was so little that it could be considered as negligible. These poor results clearly show that the application of nitrate of potash, ranging from 4.4 to 28.6 grams, was insufficient to bring about a maximum development of the young lanzon plants, hence the fertilizer, nitrate of potash, may be considered as not suitable for these plants.

Comparison of the nutritive values of the arbitrarily selected cultures. To be able to effect a study of the comparative nutritive values of the arbitrarily selected cultures from each of the tables of results thus far studied, it was deemed necessary to build the following tabulation:

CULTURE[a]	GROSS QUANTITY OF FERTILIZER	NUTRIENT CONTENTS OF FERTILIZER			FRESH WEIGHT OF PLANT		DATA TAKEN FROM
		N	P_2O_5	K_2O	Actual	Relative	
		grams	*grams*	*grams*	*grams*		
IV	35.2 grams Corona Cocos	2.112	2.816	3.168	23.9	198	Table 1
V	57.8 grams Corona Cocos	3.432	4.576	5.148	19.2	159	
VI	None (control)	—	—	—	12.1	100	
IV-a	35.2 grams Ammo-Phos 13-48	3.768	16.896	—	57.8	572	Table 2
V-a	57.2 grams Ammo-Phos 13-48	6.124	27.456	—	75.6	749	
VI-a	None (control)	—	—	—	10.1	100	
I-b	8.8 grams sulfate of ammonia	1.492	—	—	14.0	215	Table 3
II-b	22.0 grams sulfate of ammonia	3.732	—	—	10.8	166	
IV-b	None (control)	—	—	—	5.5	100	
III-c	13.2 grams sulfate of ammonia 13.5 grams superphosphate ... 30.0 grams horse manure	2.386	2.508	0.144	50.4	438	Table 4
IV-c	6.76 grams nitrate of potash .	0.698	—	—	26.8	233	
VIII-c	None (control)	—	—	—	11.5	100	

[a] To distinguish the cultures that were taken from one table from the cultures taken from the other tables; letter designations -a, -b, and -c are used.

The data in the tabulation were compiled from tables 1 to 4 inclusive. The comparison of the nutritive values of the different cultures in the tabulation is based mainly on the *green weight* of plants. From each table were taken the two arbitrarily selected as the best cultures and the corresponding control culture.

It is of interest to note in the tabulation that with the exception of the sulfate of ammonia set in which the yields in *green weight* of the plant were relatively too low, the yields of the control cultures under the same criteria in the other culture sets were about the same. It appears, therefore, that the data now found in the tabulation are fairly comparable.

No explanation can now be offered for the exceptionally low yields produced by the control culture in the ammonium sulfate set. But, even if the results obtained from the sulfate of ammonia lot were each to be arbitrarily doubled, the results would not be any better than such cultures as cultures IV-a and V-a, which were supplied with Ammo-Phos 13–48. Moreover, as may be recalled, the best results from the set of cultures supplied with sulfate of ammonia were obtained from cultures I-b and II-b, which were supplied with the two smallest amounts of the fertilizer. It might be, therefore, that the rather low yields obtained from sulfate of ammonia lot was due to the excess use of the fertilizer, and that smaller amounts should be tried.

Considering the rest of the cultures in the preceding tabulation, it will be seen that the three most promising culture media, arranged in the descending order, are cultures V-a, IV-a, and III-c. Culture V-a, the best of all, was supplied with 57.2 grams of Ammo-Phos 13–48. Culture IV-a, the next best, received 35.2 grams of Ammo-Phos 13–48. Culture III-c was supplied with a mixture of 13.2 grams of ammonium sulfate, 13.5 grams of superphosphate, and 30 grams of air-dry horse manure.

Correlating the nutrient contents, or the N-P_2O_5-K_2O contents that were supplied by the fertilizer or mixture of fertilizers, with the yields of *green weight* of plants shown in the preceding tabulation, it will be seen that the highest yield in green weight was obtained from culture V-a in which the N and P_2O_5 contents were the highest, being a mixture of 6.124 grams N and 27.456 grams P_2O_5. It might, therefore, still be possible to improve on culture V-a, if a greater amount of Ammo-Phos 13–48 were used.

As shown by the data in the tabulation, potash (K_2O) seems not be a limiting factor in the present study. It appears that young lanzon plants can be grown successfully in pots of tuff soil even

though no extra supply of potash were supplied to that naturally present in the tuff soil, provided nitrogen and phosphoric acid are present in the culture medium in more or less liberal amounts.

Cultures in clay-loam soil

Before discussing the results that were obtained from this part of the present study, it should be stated that no special attempts were made in the plan to correlate the experiments under cultures in tuff soil with the experiments under clay-loam soil. The attempt was not made as literature on fertilizer studies on lanzon plants was not at hand and because the time for this study was too limited. It is a matter of regret that none of the commercial "mixed" fertilizers, especially the Ammo-Phos 13–48, that gave good results on the plants when grown in tuff soil were tried when the plants were grown in clay-loam soil.

Relative nutritive values of single fertilizers to young lanzon plants grown in clay-loam soil. Together with control cultures, that is, cultures in which the young lanzon plants were grown in clay-loam only and were not supplied with fertilizers, the three *single* fertilizers, *sulfate of ammonia, nitrate of potash,* and *superphosphate,* were separately tried on the plant in the same amounts. The results (see table 6) show that of the three fertilized cultures, culture II which was supplied with 7.8 grams of nitrate of potash in two applications gave the highest yield under the criteria of results employed, except possibly on *number of leaves.* The sulfate of ammonia (culture I) when supplied at the rate of 7.8 grams per pot or plant, proved once more to be even harmful to the plant. This statement is based on the fact that under most of the criteria of results the unfertilized culture (culture IV) gave better results than those obtained from culture I, in which the plants were supplied with sulfate of ammonia. Even culture III, in which the plants were supplied with superphosphate, was better than culture I.

However, the best culture recorded in table 6, in which the plants were supplied with 7.8 grams of nitrate of potash in two applications, was in term of fresh weight of plants only 127 per cent better than the unfertilized culture. And, as may be recalled, this fertilizer gave also a similar rather moderate increase in yields[6] over those obtained from control culture when the plants were grown in the tuff soil. Moreover, when the young plants were supplied with 57.2 grams of Ammo-Phos 13–48 the increase of *yields* over

[6] The *yields* here refer not to fruits but to data under the criteria of results employed in this study.

those obtained from the control culture was as much as 650 per cent. Therefore, nitrate of potash used at the rate of 7.8 grams per plant was not *particularly* beneficial to the young lanzon plants. Culture III, although second best in the set and supplied with 7.8 grams of superphosphate, gave only about 84 per cent better yield in *fresh weight* of plants than the control culture.

Nutritive values of certain single fertilizers when used singly or in certain mixtures. In term of *fresh weight* of plants, the data in table 7 seem to show that the three fertilized cultures that gave a higher yield than that of the control culture were, in descending order, cultures VI, I, and II. However, judged by the stand of the plants as shown in figure 5, culture I should be excluded from the group, because the relatively high data for this culture were due to one plant that happened to be *exceptionally* well developed. In other words, 80 per cent of the plants in the 5-replicated culture I were poorly developed. Therefore, there remains cultures VI and II in the lot as the most promising for the young lanzon plants.

But, culture II, in term of fresh weight of the plant, was only 35 per cent better than the control culture, and as shown in figure 5, the relatively rather high yield obtained from culture II was due also to one plant which was *exceptionally* well developed. Therefore, the choice for the best or most promising culture medium for the plant narrowed down to culture VI, and as may be seen in figures 4 and 5 the plants which were supplied with 7.8 grams of superphosphate were fairly well developed.

Further examination of the data in table 7 reveals the fact that the rest of the cultures in the set were each supplied with a relatively small amount of superphosphate. Incidentally, the yields, obtained from any of these cultures were much lower than those obtained from culture VI. It appears, therefore, that the principal growth promoting factor for the best growth and development of young lanzon plants when grown in clay-loam soil was *phosphorus* or *phosphate.*

SUMMARY AND CONCLUSIONS

1. This study dealt with effects of fertilizers on the growth and development of young lanzon plants (*Lansium domesticum* Correa), and consisted of seven sets of cultures.

2. On the accepted belief that the vigor of a plant when young materially and directly influences the later life of that plant, the

results from the present study should be of value. It not being possible to use the best criterion of results of fertilizer studies with lanzon plants which, of course, is the amount and the quality of the fruits produced, the study was made on young plants of this fruit.

3. Of the cultures supplied with Corona Cocos, the culture that received 35.2 grams of the fertilizer in tuff soil was the best, although it was only about 98 per cent better than the control culture, which received no fertilizer. The *best* culture in the Corona Cocos lot was not any better than the *poorest* culture in the Ammo-Phos 13–48 lot.

4. In term of the *fresh weight* of the plants, the cultures that were supplied with Ammo-Phos 13–48 improved the development of the young lanzon plants as much as from 260 to 650 per cent. The culture which received 57.2 grams of Ammo-Phos 13–48 in two applications was found to be about 650 per cent better than the control culture.

5. The best culture medium which contained 57.2 grams of Ammo-Phos 13–48 supplied the young lanzon plants with 6.12 N, and 27.46 grams P_2O_5. When the fertilizer ingredients from the fertilizer and from the soil were combined, the best culture medium found contained 12.72 grams N, 49.06 grams P_2O_5 and 25.2 grams K_2O.

6. The beneficial effects that the sulfate of ammonia gave to the young lanzon plants grown in tuff soil in pots were in inverse order to the amount of the fertilizer used. The best culture medium in this lot contained 8.8 grams of sulfate of ammonia, but in term of the *fresh weight of plant*, this culture was only 115 per cent better than the control culture. The best culture received 1.49 grams N from the fertilizer and when this fertilizer ingredient was added to those supplied by the tuff soil, the result was found to be 8.09 grams N, 21.6 grams P_2O_5, and 25.2 grams K_2O.

7. In term of *fresh weight* of plants, the culture which was supplied with 13.2 grams of sulfate of ammonia, 13.5 grams of superphosphate and 30 grams air-dry horse manure turned out to be 338 per cent better than the control culture. This fertilizer mixture supplied the young lanzon plants with 2.39 grams N, 2.51 grams P_2O_5 and 0.144 grams K_2O. When the nutrient contents from the fertilizers and those from the tuff soil were combined, the total food nutrients were found to be 7.34 grams N, 18.71 grams P_2O_5 and 19.04 grams K_2O.

8. All the cultures that were supplied with nitrate of potash only were much inferior to the cultures supplied either with Ammo-

Phos 13–48 or with sulfate of ammonia. Potash seems not to be a beneficial factor for the growth and development of young lanzon plants.

9. It appears that the principal beneficial factor for the best growth and development of the young lanzon plant when grown in tuff soil was a relatively large amount of nitrogen and of phosphorus, but when grown in clay-loam soil *phosphorus* or *phosphate* alone was found to be the principal growth-promoting ingredient.

TABLE 1

Data showing effects on the growth and development of young lanzon plants of commercial fertilizer, Corona Cocos when applied in varying amounts in pots containing tuff soil. Data as average of five replications. Experiment from January 12, 1932, to December 7, 1932

CULTURE NO.	FERTILIZER USED						TOTAL GROWTH INCREMENT OF PLANTS	NUMBER OF LEAVES AT HARVEST	INCREASE IN NUMBER OF LEAVES			LEAF PRODUCT	FRESH WEIGHT				
	Gross quantity	Nutrient contents							Simple	Compound	Simple and compound		Leaves	Stem	Root	Whole plant	
		N	P	K	P_2O_5	K_2O										Actual value	Relative value [a]
	grams	*grams*	*grams*	*grams*	*grams*	*grams*	*cm.*					*sq. cm.*	*grams*	*grams*	*grams*	*grams*	
I	8.8	0.528	0.306	0.658	0.704	0.792	13.4	5.8	2.8	1.0	3.8	382.7	5.0	2.1	4.0	11.1	92
II	13.2	0.492	0.460	0.986	1.056	1.188	16.7	7.4H	3.6	1.8H	5.4H	457.7	7.3	2.7	6.4	16.4	136
III	22.0	1.320	0.768	1.764	1.760	1.980	17.5H	6.4	3.0	1.4	4.4	490.7	7.6H	2.6	7.0	17.2	142
IV	35.2	2.112	1.228	2.630	2.816	3.168	17.6H	7.0	2.8	2.2H	5.0	570.9H	8.8H	4.0H	11.0H	23.9H	198H
V	57.2	3.432	1.996	4.272	4.576	5.148	16.4	9.6H	6.4H	1.2	7.6H	601.6H	7.6H	2.8H	8.7H	19.2H	159H
VI	None (control)	—	—	—	—	—	13.1	6.8	4.2H	0.6	4.8	375.8	5.3	1.7	5.0	12.1	100

[a] The actual value for the control culture was arbitrarily taken as 100 and the rest of the actual values under the same criterion were reduced relatively.

TABLE 2

Data showing effects on the growth and development of young lanzon plants of commercial fertilizer Ammo-Phos 13–48 when applied in varying amounts in pots containing tuff soil. Data as averages of five replications. Experiment from January 12, 1932 to December 7, 1932

CULTURE NO.	FERTILIZER USED						TOTAL GROWTH INCREMENT OF PLANTS	NUMBER OF LEAVES AT HARVEST	INCREASE IN NUMBER OF LEAVES			LEAF PRODUCT	FRESH WEIGHT				
	Gross quantity	Nutrient contents							Simple	Compound	Simple and compound		Leaves	Stem	Root	Whole plant	
		N	P	K	P_2O_5	K_2O										Actual value	Relative value [a]
	grams	*grams*	*grams*	*grams*	*grams*	*grams*	*cm.*					*sq. cm.*	*grams*	*grams*	*grams*	*grams*	
I	8.8	0.942	1.842	—	4.224	—	25.9	8.0	2.2	3.6	5.8	1034.1	15.4	7.0	14.0	36.5	361
II	13.2	1.414	2.762	—	6.336	—	26.4	9.0H	2.6H	4.4	7.0	1207.9	17.0	7.1	14.3	38.3	379
III	22.0	2.356	4.604	—	10.560	—	27.1	6.8	1.0	3.8	4.8	1079.1	17.0	8.0	17.3	42.3	419
IV	35.2	3.768	7.366	—	16.896	—	33.6H	8.8	0.8	5.6H	6.4H	1457.7H	22.6H	11.6H	23.6H	57.8H	572H
V	57.2	6.124	11.970	—	27.456	—	35.2H	9.8H	0.6	6.2H	6.8H	1797.2H	26.9H	16.5H	32.1H	75.6H	749H
VI	None (control)	—	—	—	—	—	11.6	70.	3.6H	0.4	4.0	352.2	4.9	1.5	3.6	10.1	100

[a] The actual value for the control culture was arbitrarily taken as 100 and the rest of the actual values under the same criterion were reduced relatively.

TABLE 3

Data showing effects on the growth and development of young lanzon plants of commercial fertilizer, sulfate of ammonia when applied in varying amounts in pots containing tuff soil. Data as averages of triplicate cultures. Experiments from January 12, 1932 to December 7, 1932

CULTURE NO.	FERTILIZER USED						TOTAL GROWTH INCREMENT OF PLANTS	NUMBER OF LEAVES AT HARVEST	INCREASE IN NUMBER OF LEAVES			LEAF PRODUCT	FRESH WEIGHT				
	Gross quantity	Nutrient contents							Simple	Compound	Simple and compound		Leaves	Stem	Root	Whole plant	
		N	P	K	P_2O_5	K_2O										Actual value	Relative value [a]
	grams	*grams*	*grams*	*grams*	*grams*	*grams*	*cm.*					*sq. cm.*	*grams*	*grams*	*grams*	*grams*	
I	8.8	1.492	—	—	—	—	15.2H	5.0H	2.0H	0.3	2.3H	320.7H	4.3H	3.1H	6.6H	14.0H	215H
II	22.0	3.732	—	—	—	—	16.1H	4.3	0.3	2.0H	1.7H	168.2	2.9	2.3H	5.5H	10.8H	166H
III	57.2	9.704	—	—	—	—	12.5	3.3	1.3	2.0H	0.7	104.5	2.6	1.9	4.0	8.5	131
IV	None (control)	—	—	—	—	—	8.1	4.7H	1.7H	-	1.7H	228.5H	3.0H	0.9	2.6	6.5	100

[a] The actual value for the control culture was arbitrarily taken as 100 and the rest of the actual values under the same criterion were reduced relatively.

TABLE 4

Data showing effects on the growth and devclopment of young lanzon plants of different fertilizers when applied singly or in combination in pots containing tuff soil. Data as averages of five replications. Experiments from January 12, 1932 to December 7, 1932

CULTURE NO.	FERTILIZER USED: Gross quantity	Nutrient contents: N	P	K	P_2O_5	K_2O	TOTAL GROWTH INCREMENT of PLANTS	NUMBER OF LEAVES AT HARVEST	INCREASE IN NUMBER OF LEAVES: Simple	Compound	Simple and compound	LEAF PRODUCT	FRESH WEIGHT: Leaves	Stem	Root	Whole plant: Actual value	Relative value[a]
		grams	*grams*	*grams*	*grams*	*grams*	*cm.*					*sq. cm.*	*grams*	*grams*	*grams*	*grams*	
I	13.2 grams sulfate of ammonia	2.238	—	—	—	—	12.9	4.0	1.0	1.0	2.0	217.2	4.4	2.2	5.4	12.0	104
II	13.2 grams sulfate of ammonia 30.0 grams horse manure	2.386	0.034	0.120	0.078	0.144	10.7	4.3	1.8	0.5	2.3	203.8	3.3	1.5	4.5	9.2	80
III	13.2 grams sulfate of ammonia 13.5 grams superphosphate 30.0 grams horse manure	2.386	1.094	0.120	2.508	0.144	32.3H	9.2H	2.4	4.8H	7.2H	1278.1H	19.9H	9.2H	21.4H	50.4H	438H
IV	6.76 grams nitrate of potash	0.698	—	—	—	—	22.3H	7.6H	3.6H	2.0	5.6H	825.3H	12.1H	4.1H	10.6H	26.8H	233H
V	6.76 grams nitrate of potash 30.0 grams horse manure	0.846	0.034	0.120	0.078	0.144	15.9	7.0	3.8H	1.2	5.0	592.0	8.8	2.4	6.7	17.9	156
VI	6.76 grams nitrate of potash 13.5 grams superphosphate 30.0 grams horse manure	0.846	1.094	0.120	2.508	0.144	20.1	7.5	3.5	2.0	5.5	596.4	10.0	3.3	8.6	21.8	190
VII	13.5 grams superphosphate	—	1.060	—	2.430	—	16.1	7.0	2.8	2.2H	5.0	506.9	7.4	2.7	8.1	18.1	157
VIII	None (control)	—	—	—	—	—	12.4	6.2	3.4	0.8	4.2	350.0	5.0	1.8	4.8	11.5	100

[a] The actual value for the control culture was arbitrarily taken as 100 and the rest of the actual values under the same criterion were reduced relatively.

TABLE 5

Data showing effects on the growth and development of young lanzon plants of different commercial fertilizers when applied in varying amounts in pots containing tuff soil. Data as averages of triplicate cultures. Experiments from June 27, 1932 to January 23, 1933

CULTURE NO.	FERTILIZER USED						TOTAL GROWTH INCREMENT OF PLANTS	NUMBER OF LEAVES AT HARVEST	INCREASE IN NUMBER OF LEAVES			LEAF PRODUCT	FRESH WEIGHT				
	Gross quantity	Nutrient contents							Simple	Compound	Simple and compound		Leaves	Stem	Root	Whole plant	
		N	P	K	P_2O_5	K_2O										Actual value	Relative value[a]
		grams	*grams*	*grams*	*grams*	*grams*	*cm.*					*sq. cm.*	*grams*	*grams*	*grams*	*grams*	
	A. Fertilized with nitrate of potash																
I	4.4 grams nitrate of potash	0.454	—	—	—	—	7.2	4.3	1.3	—	1.3	212.5	3.4	0.8	2.3	6.5	86
II	6.6 grams nitrate of potash	0.681	—	—	—	—	10.4	6.7	3.3	0.3	3.7	234.3	3.5	0.8	3.0	7.5	103
III	11.0 grams nitrate of potash	1.135	—	—	—	—	9.9	6.7	2.7	1.0	3.7	381.9	5.7	1.4	5.3	12.5	171
IV	17.6 grams nitrate of potash	1.816	—	—	—	—	7.8	4.3	0.3	0.7	1.0	298.6	3.7	0.8	2.4	7.0	96
V *b*	28.6 grams nitrate of potash	2.952	—	—	—	—	8.6	3.5	0.5	—	0.5	228.6	3.3	1.2	3.2	7.6	104
	B. Fertilized with Ammo-Phos 13–48																
I-a*b*	4.4 grams Ammo-Phos 13-48	0.471	0.921	—	2.112	—	10.5	6.0	1.5	1.5	3.0	429.7	6.3	1.6	5.9	13.8	188
II-a	6.6 grams Ammo-Phos 13-48	0.707	1.381	—	3.168	—	18.0	8.0	1.7	1.7	3.3	713.9	11.1	2.9	8.2	22.1	303
III-a*b*	11.0 grams Ammo-Phos 13-48	1.178	2.302	—	5.280	—	18.4	9.0	2.0	3.0	5.0	816.2	12.0	2.9	8.8	23.6	323
IV-a*b*	17.6 grams Ammo-Phos 13-48	1.884	3.683	—	8.448	—	18.1	9.0	2.5	2.5	5.0	992.5	11.5	3.4	8.5	23.4	321
V-a	28.6 grams Ammo-Phos 13-48	3.062	5.985	—	13.728	—	21.1	8.3	2.3	2.0	4.3	643.1	10.1	3.1	8.7	22.0	301
	C. Fertilized with sulfate of ammonia																
I-b	4.4 grams sulfate of ammonia	0.746	—	—	—	—	13.8	5.0	2.0	2.0	-	495.6	7.2	2.5	8.7	18.4	252
II-b	6.6 grams sulfate of ammonia	1.120	—	—	—	—	15.8	6.3	1.0	3.0	2.0	470.1	8.0	3.1	10.5	21.6	296
III-b	11.0 grams sulfate of ammonia	1.866	-	—	—	—	15.7	7.0	0.7	1.3	2.0	496.1	7.9	2.7	10.1	20.7	284
IV-b	17.6 grams sulfate of ammonia	2.986	—	—	—	—	11.6	5.0	1.0	2.0	1.0	295.0	4.4	1.6	4.8	10.8	148
V-b	28.6 grams sulfate of ammonia	4.852	—	—	—	—	8.6	4.5	0.0	—	0.0	167.7	2.6	1.0	2.9	6.4	88
VI *c*	None (control)	—	—	—	—	—	8.4	6.7	3.0	0.7	3.7	152.0	3.0	0.9	3.4	7.3	100

a The actual value for the control culture was arbitrarily taken as 100 and the rest of the actual values under the same criterion were reduced relatively.

b Data are averages of two similar cultures, one of the triplicate cultures having been destroyed by typhoon on September 15, 1932.

c This is the control culture for all the cultures.

TABLE 6

Data showing effects on the growth and development of young lanzon plants of different fertilizers when applied singly in pots containing clay loam soil. Data as averages of four replications. Experiments from January 12, 1932 to December 8, 1932

CULTURE NO.	FERTILIZER USED						TOTAL GROWTH INCREMENT OF PLANTS	NUMBER OF LEAVES AT HARVEST	INCREASE IN NUMBER OF LEAVES			LEAF PRODUCT	FRESH WEIGHT				
	Gross quantity	Nutrient contents							Simple	Compound	Simple and compound		Leaves	Stem	Root	Whole plant	
		N	P	K	P_2O_5	K_2O										Actual value	Relative value [a]
		grams	*grams*	*grams*	*grams*	*grams*	*cm.*					*sq. cm.*	*grams*	*grams*	*grams*	*grams*	
I	7.8 grams sulfate of ammonia	1.324	—	—	—	—	11.5	6.0	2.5	0.5	3.0	310.1	4.4	2.1	5.3	11.7	84
II	7.8 grams nitrate of potash	0.804	—	—	—	—	23.3	7.5	0.8	3.8	4.5	913.5	13.5	5.3	13.0	31.8	227
III	7.8 grams superphosphate	—	0.612	—	1.404	—	20.3	7.8	2.0	2.8	4.8	737.9	10.8	3.9	11.2	25.8	184
IV	None (control)	—	—	—	—	—	12.1	6.3	2.8	0.5	3.3	403.5	6.0	2.0	6.0	14.0	100

[a] The actual value for the control culture was arbitrarily taken as 100 and the rest of the actual values under the same criterion were reduced relatively.

TABLE 7

Data showing effects on growth and development of young lanzon plants of different fertilizers when applied singly or in combination in pots containing clay loam. Data as averages of five replications. Experiment from February 12, 1932 to December 8, 1932

CULTURE NO.	FERTILIZER USED: Gross quantity	Nutrient contents: N	P	K	P_2O_5	K_2O	TOTAL GROWTH INCREMENT OF PLANTS	NUMBER OF LEAVES AT HARVEST	INCREASE IN NUMBER OF LEAVES: Simple	Compound	Simple and compound	LEAF PRODUCT	FRESH WEIGHT: Leaves	Stem	Root	Whole plant: Actual value	Relative value[a]
		grams	*grams*	*grams*	*grams*	*grams*	*cm.*					*sq. cm.*	*grams*	*grams*	*grams*	*grams*	
I	7.8 grams sulfate of ammonia	1.324	—	—	—	—	12.0	6.0	2.6	1.4	4.0	373.6	5.8	3.4	9.1	18.3	156
II	7.8 grams sulfate of ammonia 1.9 grams superphosphate	1.324	0.150	—	0.342	—	12.5	6.0	2.8	1.2	4.0	425.8	4.6	4.2	7.0	15.8	135
III	1.90 grams sulfate of ammonia 1.90 grams superphosphate 1.90 grams nitrate of potash	0.518	0.150	—	0.342	—	10.4	5.4	2.4	0.8	3.2	374.0	2.7	1.1	4.1	8.0	68
IV	7.8 grams sulfate of ammonia 1.9 grams horse manure	1.334	0.002	0.008	0.001	0.010	9.4	5.0	3.0	—	3.0	196.7	2.4	1.3	2.5	6.2	53
V	7.8 grams sulfate of ammonia 1.9 grams superphosphate 1.9 grams horse manure	1.334	0.152	0.008	0.346	0.010	11.0	4.0	1.2	0.8	2.0	315.7	4.0	1.6	5.1	10.7	91
VI	7.8 grams superphosphate	—	0.612	—	1.401	—	22.7	7.3	2.5	2.8	5.3	876.7	10.8	4.8	14.1	29.3	255
VII	None (control)	—	—	—	—	—	10.7	6.6	3.0	0.6	3.5	389.8	4.9	1.9	4.9	11.7	100

[a] The actual value for the control culture was arbitrarily taken as 100 and rest of the actual values under the same criterion were reduced relatively.

ABSTRACT[1]

The effect of spacing and rate of seeding on the yield and amount of starch of arrowroot. MONICO NECESITO. (*Thesis presented for graduation, 1929, with the degree of Bachelor of Agriculture from the College of Agriculture, No. 433; Experiment Station contribution No. 989*).—The objects of the work were to study the effect of spacing and to determine the effect of rate of seeding upon the yield of arrowroot and the amount of starch content.

A piece of land 800 sq. m. in area was prepared thoroughly with native plow and harrow, after which furrows were made. The land was divided into three large lots and each large lot was again divided into five small plots of 3 × 20 m. each.

Fresh and well developed suckers of arrowroot were planted. One sucker was planted to lot I; to lot II, two suckers; and to lot III, three suckers. Plot I was planted at 1.00 × 1.00 m. distance; plot II, 1.00 × 0.75 m.; plot III, 1.00 × 0.50 m.; plot IV, 0.75 × 0.75 m.; and plot V, 0.75 × 0.50 m.

The rhizomes were dug up after nine months and thoroughly cleaned.

The starch content of the arrowroot was extracted by pounding the rhizomes in a mortar, then mixing the pounded material with water in petroleum cans at the rate of one part pounded arrowroot to three parts of water, and then squeezing the arrowroot thoroughly. The fibrous materials were removed and the liquid containing the starch was stirred well and poured into a settling tank. The residual starch was obtained by pouring off the clear water. The starch was taken from the tank and dried to constant weight in the sun.

The conclusions of the author were summarized as follows:

1. In general, the greater the distance between the plants in the plot, the greater was the average weight of the rhizomes.

2. In all the plantings the 1.00 × 0.50 m. distance gave the highest average yield of the rhizomes per row.

3. In general, the yield of starch was not affected by the distance of planting.

[1] Abstract prepared as part of the required theme work in English 3a, College of Agriculture.

4. Three plants to a hill at the distances 1.00 × 0.50 m. and 1.00 × 0.75 m. gave a higher yield of starch than the other distances of planting; with two plants to a hill, 1.00 × 0.75 m. gave the highest yield.

5. With one plant to a hill, the highest yield of rhizomes was obtained at distances 1.00 × 1.00 m., 1.00 × 0.75 m. and 1.00 × 0.50 m.; two plants to a hill, 1.00 × 0.50 m.; three plants to a hill, 1.00 × 0.50 m., and 1.00 × 0.75 m.

6. At the same distances of planting, one plant to a hill gave a higher computed yield of rhizomes per hectare than the other two rates of planting.

7. With all the distances tried, two plants to a hill, gave the highest yield of starch; one plant to a hill, second highest; three plants to a hill, the lowest.

8. The highest yield of both rhizomes and amount of starch on hectare basis was obtained at distance 1.00 × 0.50 m.

9. A higher yield of rhizomes did not necessarily mean a higher yield of starch.

—*Abstract by Felipe Abrogar*

KERNELS

"CORN FROM THE SHEAVES OF SCIENCE"

A thorough study of the morphology and anatomy of the "buñga" plant has been completed.

Do not plant Latundan banana in a field badly infested with the banana-wilt fungus *Fusarium oxysporum* Schl. f. 3. Plant Lacatan, Buñgulan, Ternate or Saba instead.

Operation with alcohol, 190 proof, motor fuel is characterized by the absence of fuel knock, clean combustion chamber and satisfactory power.

Ten centavos worth of beef with bone contains more nutrients than ten centavos worth of beef without bone. Ten centavos worth of chicken contains more nutrients than ten centavos worth of turkey.

The use of lime water as an egg preservative is to be preferred to other substances because it is inexpensive, readily obtained and will preserve eggs for as long a period as eight months.

To lay out 100 meters of woven wire fence using ipilipil or madre cacao for posts costs approximately ₱28.30, using concrete posts, approximately ₱46.05.

The average butter fat test of the milk of various dairy animals are as follows: Philippine carabao, 10.17 per cent; Indian buffalo, 7.31 per cent; Philippine cow, 3.90 per cent; Indian Nellore cow, 2.90 per cent; Red Scindi cow, 2.80 per cent; Holstein cow, 2.73 per cent; doe, 4.60 per cent.

Sugar cane tops can be successfully ensiled. Cattle and water buffaloes both eat this silage with relish.

Crop rotation does not only improve soil conditions and help in the maintenance of soil fertility but it also serves to starve plant pathogens and insect pests by withholding their host or hosts from the crop series for several planting seasons.

CURRENT NOTES

Instances have come under notice in recent years of farmers suffering severe losses of pigs from absolute lack of vitality in certain of the litters. In some of these litters the affected suckers were the progeny of sows with otherwise normal litters, kept under exactly the same conditions. In other instances they appeared to be only the progeny of certain sows that exhibited these indications of bodily weakness. In some cases the suckers develop well for the first three, four, or even six or seven weeks, then they begin to sicken, dropping off one by one until most, if not all, had died. In many of these cases there did not appear to be any specific disease present, though in one or two instances it was evident that the sow had suffered from inflammation of the udder, and had not regained her normal milk supply; but in most instances both the sow and her progeny appeared normal up to the stage referred to.

Viewing the position as not althougher uncommon and as one likely to occur at any time, it would appear that these are cases in which the lack of vitality indicates a serious lack of readily available nutriment in the food, also a lack of vitamins—those strength-giving units in food about which we have heard so much and know so little. In countries overseas it is generally thought that hairlessness in newly-born pigs is associated with the development of goitre, a peculiar disease about which, also, pig raisers know too

little. Dr. John M. Evvard, one of the most prominent authorites on pig raising in the United States of America, several years ago devoted a great deal of time to a study of these troubles, and in correspondence discussed with me the cause and treatment in this way:—

> Iodine such as is contained in potassium iodide, calcium and sodium iodide, recommended as additions to mineral mixtures for pigs is of immense importance in promoting the right kind of uter or prenatal development in this class of stock. If there is not enough iodine in the ration, then the absence of this material will show itself in the resulting pig crop. In this connection we are wondering if you have ever noticed any hairless pigs in the course of your work or travels. Hairlessness in new-born pigs is, in a great many cases, due to an insufficient amount of iodine in the sow's rations....
>
> Inasmuch as pigs may be handicapped because of a deficient supply of iodine and yet show no gross or unusual signs of goitre or other iodine deficiency troubles, it appears to us that it is good practice, in goitrous regions particularly, to use iodide in the feeding ration.

Queensland Agricultural Journal, May, 1932.

Among the novelties which figured at the Agricultural Exhibition in Berlin in May, 1933, Messrs. Merkel of Esslingen exhibited and submitted to the examination of the Testing Commission for Agricultural Machinery a new type of "waterproof wool".

The tests made by this Commission proved that the wool, treated by a special process, not only did not absorb water, but even threw it off. These same experiments have indeed demonstrated that a fabric of this wool, stretched, does not allow the passage of water poured over it. Waterproof wool does not lose its properties even after frequent washings. The aspect, colour and suppleness of the wool thus treated are the same as those of ordinary wool; after various trials, its porousness was not lessened.

International Review of Agriculture, February, 1934.

Cotton was used as a reinforcing material in making asphalt paving blocks exhibited at a lecture before a Washington audience of the Negro chemist, Professor George W. Carver, who has worked for many years to discover new uses for the agricultural products of the South. About 3½ per cent of the blocks, by weight, consisted of cotton; the reinforcement increases their strength and resistance to wear. Roads made of these blocks would use up forty bales of cotton to the mile. SCIENCE.

Reprinted in *The Madras Agricultural Journal*, March, 1934.

The preserving industry during the last five years has developed very considerably in England. In 1927, the production of preserved fruits and vegetables amounted to 7,840,000 tins. In 1932 it exceeded 50 million tins.

International Review of Agriculture, February, 1934.

Mixed farming widens the horizon of interests, and one can find in it that variety which becomes the spice of life. Change from the humdrum of one thing brings recreation and relaxation that means invigorating of body, mind, and spirit. The watching, helping, and encouraging of the natural laws of breeding, feeding to secure higher and better growth and production, becomes an absorption once one tastes the fruits of success therein. Always ahead and before the enticing possibility of growing better wheat, better wool, better sheep, better lambs, better pigs, and poultry is the triumph which makes effort worth while.

The factors essential in mixed farming are judgment, management, feeding, and marketing. Judgment really is included in the whole four and makes or mars the whole. It may be termed initial and incidental, and initially is concerned with securing the start or successful inauguration of mixed farming. Finance is usually the governing factor. Judgment demands purchasing the best, but the settler in new country is limited to the founds at his disposal. Aim not at quantity, but quality . . . .

The mixed farm should be conducted from the standpoint of realising the highest returns to the owner. So convinced am I of the necessity of mixed farming that I am inclined to propound the axiom "The farm which is not a mixed farm is no farm at all." In the same way a farm without permanent supplies of water cannot be considered a farm, but both are essentials.

Queensland Agricultural Journal, October, 1933.

COLLEGE AND ALUMNI NOTES

On Saturday, September 22, President Bocobo made his first visit to the College *as* President of the University. The day was a day of work for the President and the Dean and not one of idleness for the faculty and students.

The program which was carried out to the letter and strictly on time was: 9:30–11:00. A conference with faculties of the Col-

lege of Agriculture and School of Forestry in Library—President Bocobo presiding.

In this conference Dr. V. A. Tan of College of Liberal Arts read a paper on "The Problems of Student Organization and Activities". Dr. I. Panlasigui of the College of Education read a paper on "The Characteristics of a Good Examination". At 11:00 o'clock there was a general convocation in the Auditorium of faculties and students of both institutions, Dean Gonzalez presiding. The President's address which followed the singing of the college song "Men of the Forest Are We" by School of Forestry and "Hail, College Dear" by the College of Agriculture was vigorous and carried an appeal for coöperation in his policy.

The President and other Manila colleagues were guests of the faculties of the Los Baños Colleges for luncheon at Molawin Hall.

From 2:00 to 4:00 there was a conference on administration affairs in the Dean's office with Dean Gonzalez presiding. Attending this conference were Deans, Secretaries and Heads of departments. From 4:00 to 5:00 there was a military review in honor of the President by student cadets, Lt. Martelino in charge.

In the Auditorium, under the sponsorship of The Catholic Truth Society, on the evening of September 2, the Most Reverend Michael J. O'Doherty, Archbishop of Manila addressed the faculty and student body. The theme of his address was characteristics to be developed by a student that will aid in making his life happy and useful. The simple direct practical talk was given a special strength by the personality of His Grace and his delightfully modulated voice added charm.

A song by Mrs. Mamerta Manahan-Ylagan gave pleasure, as always, to her audience.

The SAR (Society for the Advancement of Research) gave its annual dinner in honor of new members on the evening of September 20. The dinner was at Molawin Hall. The initiation ceremony and address by Dr. H. Otley Beyer, Head, Department of Anthropology and Sociology, College of Liberal Arts, University of the Philippines were in the Auditorium.

Dr. F. O. Santos, President SAR reviewed the history and objects of the society and conducted the initiation of the new members with spirit.

The active members initiated were Dr. Candido Africa of the College of Medicine, Dr. Zacarias de Jesus of the College of Veterin-

ary Science and Dr. Anastacio L. Teodoro of the College of Agriculture.

The recent College graduates or seniors who give promise of value in research, who were initiated as Associate Members were: Dominador Batenga and Felix de Leon Flores, majoring in Sugar Technology, Proceso E. Alcala, majoring in Plant Physiology, Crispin R. Las Marias, majoring in Agricultural Engineering, and Getulio B. Viado majoring in Entomology.

Dean Gonzalez introduced the speaker of the evening, Doctor Beyer who gave a most interesting address on some of the "finds" of the past few years in the excavations in the Novaliches area and on the shores of Laguna de Bay.

These excavations tell much of the story of the region in times far antedating Spanish or Malayan recorded history. From the artifacts found, much of the life six, seven, eight thousand years ago is revealed. In the time alloted to an address Doctor Beyer could give only a glimpse here and there, but the glimpses were enough to awaken a keen desire for long looks into this heretofore wholly unknown past.

The ninety-sixth regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Poultry Building, College of Agriculture, on Thursday, September 27, 1934, at 7:30 p. m.

The following papers were read and discussed:

"Clarification and preservation of toddy"

By Dr. G. A. Guanzon

"Study of diameter growth of eight species in the Maquiling National Park"

By Mr. J. Seguerra

Dr. N. B. Mendiola, Head of the Department of Agronomy, gave a radio talk in October on "The College of Agriculture and New Agricultural Industries." He told of what the College has accomplished in the gathering of experimental results and assembling of economic plants and the relation of this work to the establishment of new agricultural industries. He emphasized the handicaps which the College is encountering in connection with the distribution of seeds and other planting materials to farmers desiring to plant new crops.

Physical Director Candido Bartolome and Prof. S. Hamano of the Metropolitan Police School of Osaka and two of his assistants recently inspected the experiment on toyo manufacture in the Agronomy Department. Their verdict was that our toyo is just as good, if not better, than that manufactured in Japan. We took this compliment with a grain of salt, remembering that one rule of Japanese manners is to depreciate one's own. These visitors were shown also the different fiber, coffee, cacao and rubber and oil products.

Mr. Mariano Gutierrez '17, Chief of the Agronomy section of the Bureau of Plant Industry, was a recent Campus visitor. He divided his time between the various agronomic experiments and visiting with old College chums.

A group of municipal councilors from Aliaga, Nueva Ecija under the leadership of Mr. Raymundo Bumanlag, Municipal President, were recent College visitors. They were particularly interested in toyo, broom and cassava starch manufactures. They also visited the Experiment Station where the cultures of different varieties of rice and cassava are growing.

Mr. Andres P. Goseco '20 with Mr. Justo Arrastia and Mr. Jose Valenzuela visited the Department of Agronomy recently. Mr. Goseco is at present connected with the Del Carmen Planters' Association. These men were interested in cassava growing, cassava starch manufacture, and the soybean and peanut cultures. They placed an order for three cavans of soybean seeds and about six thousand meters of cuttings of cassava.

The *Moro Outlook* of September 1 carries the news item that Mr. Theodore Schuck B.S.A. '34 had secured a good job on the *M. S. Fernbrook* which with a cargo of copra and other products sailed from Zamboanga in August for Hamburg.

FRANK LINCOLN STEVENS

IN MEMORIAM: FRANK LINCOLN STEVENS [1]

In the issue of *Science* for September 21, 1934 appears the sad news that Dr. Frank Lincoln Stevens, Professor of Plant Pathology of the University of Illinois, Urbana, Illinois, U. S. A. passed away on August 18, 1934. Professor Stevens was with us in the College of Agriculture at Los Baños from June 23, 1930 to February 22, 1931 as the first Charles Fuller Baker Memorial Professor (of Plant Pathology) in the University of the Philippines. With those of us who had the good fortune to be associated with Professor Stevens the memory of this mycologist and teacher will live for many years. He was a lovable man of uncommon personality and he contributed materially to the advancement of Philippine mycology. His contributions began during his brief residence in the College of Agriculture in 1930–1931 and extended through the following three years. In fact at the time of his death Professor Stevens had his paper on Philippine Meliolineæ in press in the *Philippine Journal of Science* in Manila.

Professor Stevens was very companionable and was very helpful to his students. As an evidence of this spirit, when he was with us all of the members of the Department of Plant Pathology staff studied under this great teacher. Each member published on their studies in joint authorship with Professor Stevens.

During the eight months that Professor Stevens was at the College of Agriculture he collected more than two thousand specimens of Philippine fungi from the provinces of Laguna, Tayabas and Mountain Province. Many of these specimens were entirely new to science. He did at Los Baños what work could best be done here and deferred the study on a great majority of the specimens until he returned to the University of Illinois where equipment and library facilities are much better than they are in the University of the Philippines.

At the beginning of his incumbency as Charles Fuller Baker Memorial Professor (of Plant Pathology) in 1930–1931 I had the privilege of writing very briefly on that portion of the biography of Professor Stevens which deals with his attainments and honorary

---

[1] General contribution from the College of Agriculture No. 444.
Received for publication November 2, 1934.

degrees, the positions he had held at various places, his membership in societies and his publications.[2] To the extensive list of titles that I prepared at that time I here add the papers that Professor Stevens prepared and published during his stay at the College of Agriculture and the articles that he wrote during the three years that followed:

1. A misnomer in the use of the term sooty mold. The Philippine Agriculturist **19**: 549. 1931.
2. Aecioid short cycle rusts of the Philippine Islands. The Philippine Agriculturist **20**: 3–17. *Fig. 1–9.* 1931. With Miss Victoria B. Mendiola.)
3. New or noteworthy Philippine fungi. The Philippine Agriculturist **20**: 87–91. *Fig. 1–3.* 1931.
4. Diseases of cultivated ginger. The Philippine Agriculturist **20**: 171–176. *Fig 1–4.* 1931. (With Juan D. Atienza.)
5. Diseases of ornamentals in the Philippines. University of the Philippines Natural and Applied Science Bulletin **1**: 249–250. *Pl. 1–3.* 1931. (With E. F. Roldan.)
6. Two diseases caused by *Diplodia*. The Philippine Agriculturist **20**: 370–374. *Pl. 1–2; fig. 1–2.* 1931. (With M. S. Celino.)
7. Two rusts on *Wrightia laniti* (Blanco) Merr. The Philippine Agriculturist **20**: 627–631. *Fig. 1–4.* 1932.
8. Papaya leaf spot. The Philippine Agriculturist **21**: 9–14. *Fig. 1–4.* 1932. (With M. S. Celino.)
9. Two fungous invasions often following the coconut leaf miner, *Promecotheca cumingii* Baly. The Philippine Agriculturist **21**: 80–82. *Fig. 1, 2.* 1932.
10. Additional Philippine Uredineæ. University of the Philippines Natural and Applied Science Bulletin **2**: 441–447. *Fig. 1.* 1932.
11. Philippine Hemisphæriaceæ. University of the Philippines Natural and Applied Science Bulletin **3**: 21–26. *Fig. 1–4.* 1933. (With Mathilda Schneider.)

In addition to these eleven titles Professor Stevens edited the manuscript left by the late Dean Charles Fuller Baker entitled *Second supplement to the list of the lower fungi of the Philippine Islands.* This paper was published in the *Philippine Journal of Science* **46**: 479–536. He made many additions to the references and made the manuscript as nearly up to date as was possible.

At the time of his death Professor Stevens' contribution entitled *Philippine Meliolineæ*, which was illustrated by E. F. Roldan, a former student of Professor Stevens in America, was in page proof in the *Philippine Journal of Science.*

From the University of Illinois at Urbana he sent to the Herbarium of the Department of Plant Pathology of the College of Agri-

---

[2] OCFEMIA, G. O. 1930. Frank Lincoln Stevens: First Charles Fuller Baker Memorial Professor of the University of the Philippines. The Philippine Agriculturist **19**: 199–202. *With one portrait.*

culture at Los Baños a complete set of the determined specimens of Philippine fungi which he collected during his residence in the Philippines.

Professor Stevens' contributions to Philippine mycology are amply sufficient to perpetuate his memory in these Islands. Happy is a man like Professor Stevens; he lived over sixty-three years of useful life; he died after accomplishing much in his line of specialization; he was loved by his students and respected by all who knew him.

G. O. OCFEMIA
Of the Department of Plant Pathology

PROTEIN SUPPLEMENTS IN POULTRY RATIONS: III. THE OPTIMUM AMOUNT OF SHRIMP MEAL TO USE AS SUPPLEMENT IN RATIONS FOR GROWING CHICKS [1]

F. M. FRONDA AND AUGUSTO E. KABIGTING

WITH ONE CHART

Among the various animal protein supplements that are now used in the Philippines for feeding poultry, particularly growing chicks, shrimp meal has been found not only to be the most palatable but also the most profitable (Fronda, Badelles and Padilla, 1934). Proteins as a required nutrient must be supplied in the right amount to growing chicks in order that they may attain normal growth. The amount that is required during early growth is relatively large as chicks are animals that grow rapidly. Norris and Heuser (1930) reported that the increase in weight during early growth of chicks aside from water is essentially protein and ash. They stated further that only immature animals have any great capacity for storing the proteins of their food supply, and the younger the animal the more marked the ability to do this.

To raise the chicks successfully is one of the principal problems of every poultryman. In considering this problem, an important factor is the nature and proportion of the proteins present in the ration. The efficiency and economy in the production of chickens require that proteins, the most expensive kind of nutrient present in the ration, must be in the optimum proportions.

Prange, Carrick and Hauge (1928), using commercial meat and bone scraps, obtained optimum growth in young chicks when proteins from this supplement supplied 10 to 12 per cent of the rations used, or when the supplement constituted from 18.93 to 28.40 per cent of the rations. Similarly, Norris and Heuser (1930), using meat meal, obtained the greatest growth in chicks during the first 8 weeks after hatching on rations which contained approximately

[1] The data presented in this paper were taken from the thesis presented by the junior author for graduation, March, 1934, with the degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 434; Experiment Station contribution No. 990. The thesis was prepared under the direction of Dr. F. M. Fronda, Assistant Professor of Poultry Husbandry.

Received for publication July 18, 1934.

20 per cent proteins. These investigators, however, did not determine whether or not a larger quantity of proteins would have increased the rate of gain.

In what amount should shrimp meal be added to the ration for chicks to get the best results? The answer to this question should be of interest to Philippine poultry raisers. The aim of this study was to find out in just what proportion shrimp meal should be added to the basal feed in order to obtain the best result. The experiments were conducted from November, 1932 to December, 1933.

PLAN OF THE STUDY

Three sets of observations were made in this experiment. Each set covered a period of three months. Los Baños Cantonese chicks were used. These chicks were artificially hatched from the eggs collected from the Los Baños Cantonese flocks of the College.

The first set was started on January 9, 1933 and closed on April 3, 1933. This set consisted of 136 chicks which were divided into eight lots of 17 chicks each. The second set was started March 25, 1933 and closed on June 17, 1933. This set consisted of 144 chicks which were also divided into eight lots of 18 chicks each. The third set consisting of 144 chicks was started on September 9, 1933 and closed December 2, 1933. The chicks were divided into eight lots of 18 chicks each.

The chicks were all raised in fireless brooders. Each lot was placed in individual brooding quarters on the range outside with a grassy yard adjoining each brooder so the chicks had free access to green feeds. All the chicks were self-fed. The feeds used were rice bran, corn meal and shrimp meal. The following table shows the proximate analysis of the feeding materials used in the experiment.

CONSTITUENT [a]	RICE BRAN	CORN MEAL	SHRIMP MEAL
	per cent	*per cent*	*per cent*
Moisture	10.64	13.86	14.55
Ash	14.17	1.87	19.73
Protein	10.35	8.80	55.61
Crude fiber	12.73	2.97	4.24
N. F. E.	46.29	69.40	3.26
Fat	5.82	3.10	2.61
Total	100.00	100.00	100.00

[a] Analyses made in the Department of Agricultural Chemistry.

The basal feed used in each lot consisted of three parts rice bran and one part corn meal, by weight. This proportion remained constant in all the lots throughout the experiment. Shrimp meal in amounts varying from 5 to 40 per cent was added to the basal feed to form the different rations tested. The different rations studied consisted of the following:

Lots	*Rations*
I	— 95 per cent basal ration plus 5 per cent shrimp meal.
II	— 90 per cent basal ration plus 10 per cent shrimp meal.
III	— 85 per cent basal ration plus 15 per cent shrimp meal.
IV	— 80 per cent basal ration plus 20 per cent shrimp meal.
V	— 75 per cent basal ration plus 25 per cent shrimp meal.
VI	— 70 per cent basal ration plus 30 per cent shrimp meal.
VII	— 65 per cent basal ration plus 35 per cent shrimp meal.
VIII	— 60 per cent basal ration plus 40 per cent shrimp meal.

By computation based on the analysis of the feeds used, the amount of proteins in 100 kgm. of the different rations was:

LOT NO.	AMOUNT OF PROTEINS SUPPLIED FROM THE SHRIMP MEAL	TOTAL PROTEINS IN THE RATION
	kgm.	*kgm.*
I	2.78	13.17
II	5.56	15.40
III	8.34	17.63
IV	11.12	19.86
V	13.90	22.10
VI	16.68	24.34
VII	19.46	26.56
VIII	22.24	28.79

All the feeds were given in the form of mash which was placed in wooden feeding troughs kept open to the chicks at all times. Fresh water supplied in bamboo drinking troughs was always available for the chicks.

The chicks were weighed individually soon after the hatch was taken off and every week thereafter until they were 12 weeks old when observations were stopped. Other observations made were on the vigor, condition and health of the chicks in each lot. The amount of feeds consumed and the mortality of the chicks in each lot were also recorded.

RESULTS AND DISCUSSIONS

Growth of chicks. The weekly weight of the chicks was used as one of the means of determining the effect of the feeds on the rate

of growth. The average weekly weights of the different lots are given in table 1 and graphically presented in chart 1.

By reference to table 1 and chart 1, it may be seen that the initial weights of the chicks in all lots were practically the same. It may be observed also that from the first week to the second, there was no observable difference in the rate of growth of the chicks in the different lots. After this period, however, up to the end of the experimental period of 12 weeks the rate of growth was markedly different in all the lots studied.

The weights of the different lots at the age of 12 weeks were compared statistically. It was observed that the differences in the

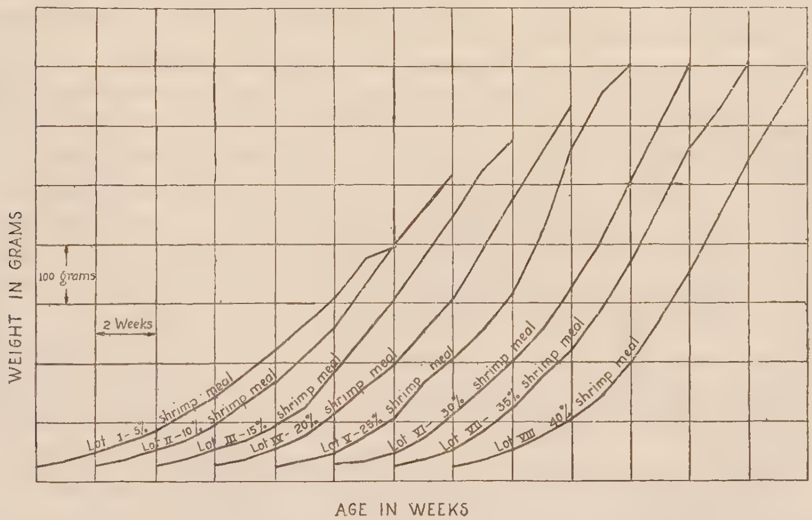


Chart 1.—Showing the average rate of growth of the chicks in the different lots studied.

weights of the chicks at this age in all lots are significant with the following exceptions: between lots V (25 per cent shrimp meal) and lot VI (30 per cent shrimp meal), V and VII (35 per cent shrimp meal), V and VIII (40 per cent shrimp meal), VI and VII, VI and VIII, and VII and VIII. In other words, as the amount of shrimp meal was increased up to 25 per cent of the ration, there was a correspondingly regular increase in the size of the birds at the age of 12 weeks. At this proportion limit, the ration contained about 22.10 per cent total proteins. Beyond this proportion, increase in the amount of shrimp meal in the ration did not produce any significant effect upon the growth of the birds. These findings are the same as

those reported by Prange, Carrick and Hauge (1928) and by Norris and Heuser (1930), both of which have been previously cited.

In this connection, it may be mentioned that in previous growth studies on Los Baños Cantonese chicks made by different investigators, the average weight at the age of 12 weeks that they reported ranged from only 308.9 grams (Dañgilan, 1925) to 514.2 grams (Mendoza, 1925). Zaratan (1929) reported 355.1 grams, Ordoveza (1927), 396.4 grams and Tioaquen (1932) 460.1 grams. Comparing these weights with those obtained in the present work, it is evident that the weights of the chicks in lots I, II and III were slightly heavier and those in lots IV, V, VI, VII and VIII, much heavier. These results show clearly the superiority of the rations used in this study, especially those that contained from 20 to 40 per cent shrimp meal.

Amount and cost of feeds consumed. Table 2 shows the amount and cost of feeds consumed by the different lots computed on the basis of 100 birds. Referring to this table it may be seen that there was practically no difference in the amount of feeds consumed by the eight lots. The cost of these feeds, however, varied because of the fact that the cost of the rations used in the different lots studied differed, depending upon the amount of shrimp meal in the ration, the more shrimp meal the ration contained the higher its cost. Paje (1927) reported that the feed consumption of every 100 chicks up to 12 weeks of age was 142.23 kgm. His result on feed consumption shows a marked difference from the feed consumption obtained in this study.

Table 3 shows the cost of producing weanlings in the different lots, computed on the basis of 100 birds. Taking as a base the final weights of the weanlings and ₱0.60 as standard cost of these per kilogram live weight, the value of 100 weanlings was found to be lowest in lot 1 (5 per cent shrimp meal), being only ₱23.71. The values of the weanlings in lots V, VI, VII and VIII were about the same, being the highest, and those in lots II, III and IV were intermediate. It may be seen from this table that the returns made by the different lots after the cost of feeds was deducted was highest, ₱33.87, in lot V, and lowest, ₱18.04, in lot I.

Mortality of chicks. Table 4 shows the total percentage of mortality of the chicks up to 12 weeks old in the different lots. It may be seen from this table that lot I had the highest mortality, and lot V, the lowest. Lots II, III, IV and VI had almost the same percentage of mortality. Likewise, lots VII and VIII had about the same.

The causes of the high mortality in lots I, VII and VIII may have been due to the feeds. Lot I may not have had enough of the shrimp meal, the protein supplement, and lots VII and VIII may have had too much. Lots VII and VIII received rations that contained 35 per cent and 40 per cent, respectively. Fronda, Badelles and Padilla (1934) reported that proteins as a required nutrient must be supplied abundantly to growing chicks if they are to attain normal growth. These workers further reported that insufficient proteins in the ration increased mortality but too much was detrimental to the chicks. Jull (1930) reported that excessive protein is harmful to both young and mature animals, as the kidneys are affected.

When the percentages of mortality in the different lots to the end of the brooding period were compared statistically, it was observed that there was no significant difference between any two of lots I, II, III, IV, VII and VIII, but when lot I was compared with lots V and VI the differences were significant. No significant differences were found when lot II was compared with lots III, IV, V, VI, VII and VIII; nor, when lot III was compared with lots IV, V, VI, VII and VIII, were significant differences observed. The difference between lots IV and VIII was slightly significant, being 11.19 ± 3.5739 per cent, but between lot IV and lots V, VI and VII no significant differences were found. Comparing lot V with lots VI, VII and VIII, there were very significant differences. Lots VI and VII when compared showed a difference of only 12.55 ± 5.2337, but comparing lot VI and lot VIII the difference was very significant. No significant difference existed between lots VII and VIII.

Considering the rate of growth, feed cost and mortality, the ration given to lot V (containing 25 per cent shrimp meal) may be considered as the best, followed by lots VI and VIII. Considering the percentage of mortality, lot V had the lowest death rate, being only 16.99 ± 2.172 per cent. Mortality that is low counts much in considering poultry raising commercially. From these results, it may be stated that the optimum amount of shrimp meal to feed to growing chicks is 25 per cent of the ration used in this study.

Variability of the weights of the chicks. When the coefficients of variability of the weights of the chicks in the different lots at 12 weeks of age were determined, the following results were obtained: lot I, 4.04 per cent; lot II, 8.85 per cent; lot III, 14.83 per cent; lot IV, 12.54 per cent; lot V, 2.37 per cent; lot VI, 6.30 per cent; lot VII, 6.05 per cent and lot VIII, 6.30 per cent. It may be seen, that in general, the chicks in all the 8 lots were fairly uniform,

those in lots III and IV being the most variable and those in lot V, the least variable. Lots VI, VII and VIII have almost the same coefficient of variability. Comparing lot I with lot II, the difference is insignificant, being only 4.81 ± 1.634 per cent. The differences between lot I and lots III and IV, however, are significant, being 10.79 ± 1.460 per cent and 8.50 ± 1.592 per cent, respectively, but between lot I and lots V, VI, VII and VIII, the differences are insignificant, being: 1.67 ± 2.394 per cent; 2.26 ± 1.503 per cent; 2.01 ± 1.664 per cent and 2.26 ± 1.385 per cent, respectively. The difference between lot II and lot IV is 5.98 ± 1.438 per cent; between lot II and V, 3.69 ± 1.570 per cent; between lot II and VI, 6.48 ± 2.380 per cent; between lot II and VII, —2.81 ± 1.640 and between lot II and VIII, —2.55 ± 1.358 per cent. Comparing lot III with lot IV, the difference is insignificant, being only —2.29 ± 1.494 per cent. The differences between lot II and lots IV, V, VI, VII and VIII are all significant. The difference between lot IV and lots V, VI, VII and VIII are not significant. The differences between lot V and lots VI, VII and VIII, and between lot VI and lots VII and VIII and between lot VII and lot VIII are not significant.

Health and vigor of chicks. Except in lot I, all the chicks were healthy and vigorous. Feather growth was more rapid in the lots the rations of which contained the higher percentages of proteins. It was observed that from lots V to VIII, most of the chicks at the age of from 6 to 8 weeks were all fully feathered, while those in lots II to IV, were from 7 to 10 weeks old before they were feathered. The chicks in lot I were the slowest in feathering. After weaning age had passed, some were still partially feathered. This slowness may have been due to the insufficiency of protein in their feeds.

SUMMARY OF CONCLUSIONS

The effect of various amounts of shrimp meal as supplement in rations for growing chicks was studied. A summary of conclusions follows:

1. The results obtained in this study show that 25 per cent shrimp meal in the ration is the optimum amount to feed to growing chicks. The lot that received the ration containing this amount of shrimp meal gave the best results, in growth, rate of mortality and cost of gain. The lot that received the ration containing only 5 per cent shrimp meal gave the poorest results.

2. There was practically no difference in the amount of feeds consumed by the different lots.

3. As the amount of shrimp meal increased in the ration the relative cost of each ration also increased.

4. Lot V (25 per cent shrimp meal) had the lowest percentage of mortality, being only 16.99 per cent, and lot I had the highest, 43.24 per cent.

5. Except in lot I, all the chicks were vigorous, healthy and active.

6. The chicks in the lots which contained 20 to 40 per cent shrimp meal were fairly uniform in size.

7. Early and complete growth of feathers of the chicks occurred in lots which contained a high percentage of shrimp meal (25 per cent to 40 per cent.)

LITERATURE CITED

DAÑGILAN, LUIS J. M. 1926. Studies on the rate of growth of Cantonese chickens. The Philippine Agriculturist 15: 303–311. *Chart 1.*

FRONDA, F. M., A. C. BADELLES, AND J. S. PADILLA. 1934. Protein supplements in poultry rations: I. Comparative studies of the effects of shrimp meal, meat scraps, tankage and fish meal as supplements in rations for growing chickens. The Philippine Agriculturist 22: 582–598. *Charts 1–2.*

JULL, MORLEY A. 1930. Poultry husbandry. ix + 639 p., 229 fig. New York: McGraw-Hill Book Company, Inc.

MENDOZA, JORGE N. The rate of growth of grade Rhode Island Red and Cantonese chickens. *Abstract* in The Philippine Agriculturist 15: 313.

NORRIS, L. C., AND G. F. HEUSER. 1930. The relation of the protein requirements of chicks to the rate of growth: I. The quantity of protein required by chicks during early growth. Poultry Science 9: 378–393. *Plates 1–2.*

ORDOVEZA, FERNANDO C. Effect of the time of hatching on growth and maturity of pullets. (Thesis presented for graduation from the College of Agriculture with the degree of Bachelor of Agriculture. 1927. Unpublished.)

PAJE, PEDRO S. 1927. The cost of raising pullets under conditions existing in the College of Agriculture. The Philippine Agriculturist 16: 35–38. *Chart 1.*

PRANGE, R. W., C. W. CARRICK, AND S. M. HAUGE. 1928. Growth values of proteins from commercial animal products: I. Meat and bone scraps. Poultry Science 7: 95–105. *Charts 1–4.*

TIAOQUEN, TELESFORO. 1933. Comparative studies on the growth and maturity of the Los Baños Cantonese and Nagoya chickens. The Philippine Agriculturist 22: 338–348. *Chart 1.*

ZARATAN, ANANIAS M. 1929. Studies on the effects on the growth of chicks of night feeding with the aid of artificial illumination. The Philippine Agriculturist 18: 387–396.

TABLE 1

Showing the average weekly weights of the chicks in the different lots

AGES	LOT I (5% SHRIMP MEAL)		LOT II (10% SHRIMP MEAL)		LOT III (15% SHRIMP MEAL)		LOT IV (20% SHRIMP MEAL)	
	Number of chicks	Average weight	Number of chicks	Average weight	Number of chicks	Average weight	Number of chicks	Average weight
		kgm.		*kgm.*		*kgm.*		*kgm.*
Day old	53	26.6 ± 1.012	53	27.2 ± 0.741	53	26.2 ± 0.229	53	26.6 ± 0.876
1 week	47	34.7 ± 2.832	48	36.6 ± 2.225	50	35.7 ± 1.146	50	36.6 ± 1.822
2 "	46	48.6 ± 2.563	47	50.9 ± 1.956	47	51.3 ± 0.944	49	54.3 ± 3.574
3 "	45	66.6 ± 0.543	47	69.4 ± 2.832	46	68.1 ± 2.563	48	78.1 ± 3.435
4 "	42	86.6 ± 0.431	44	95.2 ± 0.944	45	94.9 ± 0.458	45	112.3 ± 1.213
5 "	41	118.8 ± 0.407	42	135.0 ± 2.565	43	146.5 ± 0.485	44	158.8 ± 3.237
6 "	36	141.9 ± 0.559	39	169.4 ± 3.102	42	187.5 ± 0.978	44	199.6 ± 0.607
7 "	36	181.3 ± 3.237	39	212.6 ± 2.832	41	248.5 ± 0.499	43	253.9 ± 1.214
8 "	35	221.4 ± 0.458	39	265.5 ± 0.563	40	300.9 ± 1.214	41	309.9 ± 0.944
9 "	34	259.1 ± 0.532	38	328.4 ± 0.883	40	377.6 ± 1.483	41	395.7 ± 0.674
10 "	30	313.1 ± 0.580	37	400.2 ± 1.092	40	446.5 ± 1.822	41	476.8 ± 1.018
11 "	30	364.4 ± 0.478	37	458.5 ± 1.753	40	521.8 ± 1.956	41	557.7 ± 0.774
12 "	30	395.1 ± 0.627	37	519.4 ± 1.146	39	577.9 ± 0.876	41	636.2 ± 1.089

AGES	LOT V (25% SHRIMP MEAL)		LOT VI (30% SHRIMP MEAL)		LOT VII (35% SHRIMP MEAL)		LOT VIII (40% SHRIMP MEAL)	
	Number of chicks	Average weight	Number of chicks	Average weight	Number of chicks	Average weight	Number of chicks	Average weight
		kgm.		*kgm.*		*kgm.*		*kgm.*
Day old	53	25.6 ± 0.377	53	27.5 ± 0.175	53	26.5 ± 0.674	53	26.4 ± 0.138
1 week	50	35.9 ± 1.821	52	34.4 ± 0.182	46	36.6 ± 3.035	46	36.4 ± 1.079
2 "	49	48.5 ± 1.821	48	49.2 ± 1.618	42	53.6 ± 2.765	37	51.8 ± 1.686
3 "	48	72.6 ± 3.439	45	73.7 ± 0.620	40	80.5 ± 3.507	36	75.2 ± 1.145
4 "	47	104.9 ± 3.709	44	110.7 ± 1.753	39	120.4 ± 0.674	36	106.8 ± 2.225
5 "	46	160.4 ± 2.091	43	157.7 ± 2.765	38	170.7 ± 1.753	35	148.3 ± 2.178
6 "	45	206.4 ± 2.428	43	201.2 ± 1.146	38	221.2 ± 1.956	35	197.6 ± 0.809
7 "	45	258.2 ± 1.753	42	258.7 ± 0.944	38	293.1 ± 2.091	35	274.6 ± 1.349
8 "	45	313.9 ± 1.416	42	329.5 ± 1.146	38	373.2 ± 1.821	35	353.1 ± 0.876
9 "	45	421.0 ± 3.035	42	405.4 ± 2.023	38	467.8 ± 1.888	34	453.9 ± 1.821
10 "	45	509.3 ± 1.281	42	501.9 ± 0.742	38	567.0 ± 2.023	34	544.8 ± 0.876
11 "	45	605.5 ± 2.315	42	609.3 ± 1.483	38	630.2 ± 1.956	34	624.6 ± 1.231
12 "	45	702.2 ± 2.091	42	703.1 ± 0.944	38	705.8 ± 1.179	34	701.1 ± 0.741

TABLE 2

Showing the amount and cost of feeds consumed by the different lots computed on the basis of 100 birds

LOT NO.	AMOUNT OF SHRIMP MEAL IN RATION	AMOUNT OF FEEDS CONSUMED	COST OF FEEDS PER 100 KGM.	TOTAL COST
	per cent	*kgm.*	*pesos*	*pesos*
I	5	134.9	4.20	5.67
II	10	135.6	4.60	6.24
III	15	138.9	5.00	6.94
IV	20	140.6	5.40	7.59
V	25	142.5	5.80	8.26
VI	30	144.4	6.20	8.95
VII	35	142.0	6.60	9.37
VIII	40	137.4	7.00	9.62

TABLE 3

Showing the relative cost of production of weanlings in the different lots computed on the basis of 100 birds

LOT NO.	AMOUNT, SHRIMP MEAL IN RATION	WT. OF 100 BIRDS	VALUE OF BIRDS PER 100	COST OF FEEDS PER 100 BIRDS	RETURNS ABOVE FEED COST
	per cent	*kgm.*	*pesos*	*pesos*	*pesos*
I	5	39.51	23.71	5.67	18.04
II	10	51.94	31.16	6.24	24.92
III	15	57.79	34.67	6.94	27.73
IV	20	63.62	38.17	7.59	30.58
V	25	70.22	42.13	8.26	33.87
VI	30	70.31	42.19	8.95	33.24
VII	35	70.58	42.35	9.37	32.98
VIII	40	70.11	42.07	9.62	32.45

TABLE 4

Showing the percentage of mortality of the chicks (to 12 weeks old)

LOT NO.	SET			AVERAGE
	1st	2nd	3rd	
	per cent	*per cent*	*per cent*	*per cent*
I	35.29	27.77	66.66	43.24 ± 8.0326
II	33.53	16.66	38.88	29.69 ± 4.4895
III	11.76	16.66	50.00	26.14 ± 8.1031
IV	30.29	16.66	30.33	25.76 ± 3.0806
V	17.64	11.11	22.22	16.99 ± 2.1743
VI	23.53	16.66	27.77	22.65 ± 2.1834
VII	40.17	20.22	42.22	35.20 ± 4.7565
VIII	35.29	33.33	42.22	36.95 ± 1.8119

COST OF HARVESTING CASSAVA WITH ANIMAL DRAWN PLOW [1]

ALEJANDRO B. CATAMBAY
Of the Department of Agricultural Engineering

AND

CLEMENTE E. YANGO
Of the Department of Agronomy

WITH ONE TEXT FIGURE

Because of its commercial possibilities, cassava is one of the crops to which farmers in the Philippines are giving considerable attention. Many inquiries are received in the College from planters regarding the different phases of operation involved in cassava culture. One frequent question asked is how to lower the cost of production.

An attempt in this line was a test by Catambay (1932) [2] who compared the cost of harvesting with tractor-drawn plow and the old method of hand digging and pulling. He found that plowing up the roots was the cheaper.

The study reported in this paper was undertaken to find out if the cost of harvesting cassava can be still lowered.

The work was conducted on the College Experiment Station from June to September, 1934. The field used has an area of 8,889 square meters. The implement used was the J. D. Black Lead mold-board two-handled plow. This plow is of the general purpose type and has a cut 7 inches wide. It has a big clearance which prevents the crowding of roots at the throat; this, diminishes the chance of breaking them. Because of the size and the depth at which the plow was made to cut, two animals were required to pull it (fig. 1). The age of the cassava plants harvested ranged from 12 to 13 months.

METHOD OF HARVESTING

Before the roots were plowed up, the stems of the cassava were cut close to the ground leaving only a small portion to indicate the rows. The plow was adjusted to cut a depth of about 25 centimeters and directly below the stubs of the stem. Because two

[1] Experiment Station contribution No. 991. Prepared in the Department of Agronomy at the suggestion of Dr. N. B. Mendiola. Received for publication, October 2, 1934.

[2] CATAMBAY, A. B. 1932. Cost of harvesting cassava with a plow. The Philippine Agriculturist **21**: 277–280.

animals were used, these stubs did not interfere with them as they were made to walk on either side of the row. Two men were required to handle the plow and the animals.

TABULATED RESULTS

The results of this work are shown in the accompanying table. A total of 8,889 square meters of cassava field was harvested. The operations and labor required in harvesting were:

Cutting stems, man labor	57 hours, 56 minutes
Plowing up roots:	
Man labor	31 hours, 50 minutes
Animal labor	31 hours, 50 minutes
Picking and piling roots	44 hours, 2 minutes

Fig. 1.—Showing plow used with a two-animal team in harvesting cassava. (*a*) Clearance of plow. Note that the clearance of the plow is large enough to prevent clogging and breaking of the cassava roots.

Operations and labor required per hectare:

Cutting stems, man labor	65.17 hours
Plowing up roots:	
Man labor	35.41 hours
Animal labor	35.41 hours
Picking and piling roots	49.53 hours
Total man labor	150.11 hours
Total animal labor	35.41 hours

Cost of harvesting per hectare:

Labor cost:	
Man labor at ₱0.10 per hour	₱15.01
Animal labor at ₱0.10 per hour	3.54
Use of implement (depreciation and interest)	0.77
Total	₱19.32

DISCUSSION OF RESULTS

Cost of different methods of harvesting cassava

Catambay (1932) reported that the cost of harvesting per hectare using a tractor and plow was ₱23.96, and by hand digging with a mattock, ₱73.84. By plowing up the roots with a plow and two animals it cost to harvest one hectare ₱19.32, only. It can be clearly seen that the last method is the most economical. Harvesting with animal-drawn plow is ₱54.52 cheaper than by hand digging and ₱4.64 cheaper than with tractor-drawn plow.

Effect of the method on the roots and the field

It is a common belief that in plowing up the cassava there would be much breaking of the roots. It was found, however, that very few were broken because of the depth of plowing and also because of the large throat and clearance of the plow which gave ample space for the roots to pass through.

The field from which the cassava roots were plowed appeared much as it would after a first plowing. Although there were ridges made by the deep furrows yet the field was not uncomfortable for work animals to walk on as it would be with the holes left in the field after hand digging.

SUMMARY

1. The cost of harvesting cassava per hectare with a two-animal team and a plow was ₱19.32.

2. The cost of harvesting per hectare with tractor-drawn plow was ₱23.96, hence ₱4.64 more than with animal-drawn plow.

3. Harvesting cassava roots by hand-digging costs ₱73.84 per hectare, hence ₱54.52 more than with a plow drawn by two animals.

4. There was little breakage of the roots plowed up because of the depth of plowing and the type of plow used. The roots were plowed up to a depth of about 25 centimeters.

5. Plowing up roots saves at least one plowing for the next crop.

6. The field from which the cassava roots were plowed up was more comfortable for the animals to walk on in the following field operation than the field where the cassava roots were hand dug, as this method left holes.

TABLE 1

Showing operations and labor required in plowing cassava roots with a two-animal team

TRIALS	AREA HARVESTED	CUTTING STEMS	PLOWING UP ROOTS		PICKING UP AND PILING ROOTS
			Man	Animal	
	sq. m.	*hr.-min.*	*hr.-min.*	*hr.-min.*	*hr.-min.*
1	372	1—30	1—00	1—00	1—36
2	382	4—00	1—40	1—40	2—18
3	465	1—21	1—14	1—14	2—20
4	558	2—50	1—30	1—30	2—28
5	465	2—28	2—10	2—10	2—40
6	558	2—18	1—50	1—50	2—40
7	279	1—08	0—44	0—44	1—20
8	279	1—10	1—06	1—06	1—20
9	465	5—48	1—40	1—40	2—20
10	465	10—48	2—00	2—00	2—42
11	381	1—30	1—42	1—42	2—00
12	195	2—00	0—50	0—50	0—58
13	630	4—10	1—42	1—42	2—14
14	630	2—57	2—00	2—00	2—48
15	525	3—50	1—58	1—58	2—20
16	525	2—20	1—56	1—56	2—18
17	525	2—00	1—56	1—56	2—30
18	420	2—10	1—30	1—30	2—30
19	385	1—50	1—40	1—40	2—30
20	385	1—48	1—42	1—42	2—10
Total	8,889	57—56	31—50	31—50	44—02

THE PROXIMATE CHEMICAL COMPOSITION OF THE SEED AND OIL OF PHILIPPINE OIL-BEARING SEEDS: II. STERCULIA FOETIDA LINN.[1]

FLORENCIO A. SOLIVEN AND ISIDRO VILLAFUERTE, JR.
Of the Department of Agricultural Chemistry

WITH ONÉ TEXT FIGURE

Padilla and Soliven (1933) found that the seeds of *Sterculia foetida* Linn. contained a fair amount of oil. The plant is known in the Philippine Islands under different local names: *bañgar* (Ilocano); *kalumpang* (Tagalog, Pampango); *bobog* (Visayan); *boñgog* (Ibanag); *kurumpang* (Davao). According to Merrill (1923) this plant is distributed throughout the Philippine Islands at low and medium altitudes, from Eastern Africa to India and through Malaya to Northern Borneo. Lewkowitsch (1921) stated that this tree is cultivated in the East Indies, Indo China and Malayan Archipelago for its wood, the use of which was not given. In the Philippine Islands no regular plantation of this tree has been established.

The seeds of *Sterculia foetida* Linn. are known in commerce as "Olives of Java," "Kaloempang beans," "Beligno seeds" and "Sterculia kernels." From the kernels is derived the oil known as kalumpang oil.

According to Brill and Agcaoili (1915) this oil is used locally for illuminating purposes. In some parts of the Philippine Islands the oil when mixed with white earth is used as paint. It is said that in Java the oil is used by the natives for culinary purposes and as burning oil. In the Philippine Islands it is popularly known that when the seeds of kalumpang are eaten in sufficient quantity they act as a purgative. With the possible uses of the seeds and of the oil of kalumpang that these local uses indicate, it is important to make a chemical study of their constituents. The oil or the cake or both may some day be of value in industry.

---

[1] Experiment Station contribution No. 992. The greater portion of the data used in this paper formed part of the thesis presented by the junior author in 1934 for graduation with the degree of Bachelor of Science in Agriculture from the College Agriculture, No. 435. Received for publication, August 7, 1934.

Wendemeyer (1906) as cited by Lewkowitsch (1921) obtained 46.6 per cent of liquid oil from the kernels and 9.8 per cent of yellow buttery fat from the skin and pulp of kalumpang seeds by extraction (the nature of the solvent is not stated). He also claimed to have obtained 30.3 per cent of a liquid, light yellow oil from the whole seeds.

Lewkowitsch (1921) stated that Bontoux (1906) examined separately the oils obtained from the pulp and kernels. He found that the skin and pulp yielded 28.60 per cent and the kernels 53.60 per cent of oil, using carbon bisulfide as the solvent. He further found that the seeds gave 17 per cent of skin and pulp, 30 per cent of husks and 53 per cent kernels.

As regards the physiological action of the oil Du Mez, as cited by Brill and Agcaoili (1915), stated that the oil resembles olive oil in that when it is administered to dogs in doses of 1.5 to 3.0 ml. per kilogram body weight, it acted as a mild purgative; was non-toxic and had no irritating action. Du Mez was of the opinion that it could be used in the same manner as olive oil and might be useful for culinary purposes.

The mixed fatty acids have not been studied and the exact proportions of the acid present in the neutral oil are not given in the available literature. As a matter of fact the published work on kalumpang oil is very meagre.

The proximate chemical composition of the kernels, the cake, the ash and the oil was undertaken in this study with the aim of securing some additional data that would help in determining the real value of this species of plant.

MATERIALS AND METHODS

The seeds used in this study were obtained from the Department of Agronomy, College of Agriculture; School of Forestry, Los Baños; Economic Garden of the Bureau of Plant Industry; and from Santo Domingo, Ilocos Sur.

The seeds were cracked and the peanut-like kernels separated from the shells, and then ground fine in an ordinary meat grinder. Part of this material was used in the analysis of the seeds and of the ash.

The results herein reported were based on the composite sample of seeds and on that of the oil extracted.

The methods used in this study were essentially the same as those used in a previous investigation of this kind by the senior

author; with the exception of the determination of the acetyl value in which the method of Roberts and Schuette (1932) was used.

The number of trials conducted in finding the different results given in the different tables varied according to the constituents under consideration. The average of at least six concordant trials are reported. In table 1, thirty concordant trials; table 2, thirty-six; table 3, forty-four; table 4, twelve; table 5, twenty-four; table 6, six; table 7, five and table 9, thirty, making a total of 197 trials that

Fig. 1.—A portion of a branch of kalumpang with a bunch of pods and showing the attachment of the seeds.

were close to each other. Actually, more than 197 trials were run. but if the percentage found was far from the arithmetical mean of the rest of the determinations such trials were discarded.

The ground kernel remaining after the materials for the proximate analysis were removed was treated with ether to extract the oil. The ethereal solution was distilled to recover the major portion of the ether used. It was found in a series of trials that if, during the removal of the last traces of solvent, the mixture is heated

to about 80°C. for some time it became viscous. For this reason, extreme care was exercised during the process of the removal of the last traces of the solvent not to heat the mixture to a temperature higher than 60°C. The last traces of ether were removed by a suction device. When the ether was completely removed, the oil was dehydrated with anhydrous sodium sulfate, then filtered. The filtered oil was used in this study.

DISCUSSION OF RESULTS

The chemical composition of the kernel

The chemical composition of the kernel is given in table 1. This table was prepared so as to furnish a basis of comparing the seeds of *Sterculia foetida* Linn. with other oil-bearing seeds.

The results showed that the kernels contained 51.30 per cent ether extract and a fairly high protein content, 23.91 per cent. The figures for the ash and the ether extract agree quite closely with the corresponding analyses of Brill and Agcaoili (1915) and of Bolton and Jesson (1915). The cakes resulting from the extraction of the oil contain a fair amount of proteins and carbohydrates, there being a total of 36.76 per cent expressed on the basis of the fresh sample and 38 per cent on the dry basis. Because of their content, feeding tests would probably show that these cakes could be utilized as live stock feeds.

The chemical composition of the ash

The composition of the ash from the kernels is given in table 2.

It may be readily seen from table 2 that the ash from the kernels is high in phosphoric acid content, with a fair amount of potash and sulfur trioxide. The cake resulting from the extraction of the oil may have value as source of fertilizer if properly treated. In the fertilizer industry the cake might be utilized as filler in the compounding of other fertilizers since it contains a fair amount of potash. The ash contains a small amount of lime and ferric oxide and alumina and insoluble matter and silica.

The physical and chemical properties of the neutral oil

The oil is clear, light yellow in color. It has a pleasant odor and taste. After standing for several months white solids were found to deposit at the bottom of the container. These solids were probably due to some stearic acid and palmitic acid.

The chemical and physical characteristics of the neutral oil are given in table 3. The results of Brill and Agcaoili (1915) and Bolton and Jesson (1915) as cited by the former workers, together

with the constants for castor oil and olive oil are incorporated in the table for purposes of ready comparison, since Du Mez claimed that the oil was similar to olive oil.

The specific gravity found by means of pycnometer method was 0.9231 at 29°C. The refractive index by means of the Abbe' refractometer was found to be 1.4671 at 29°C. The solidifying point was –9° to –10°C. which showed that the oil is liquid at ordinary temperature.

It may be readily seen from table 3 that the oil may be classified as non-drying oil in accordance with the classification of Jamieson (1932), the iodine value being 77.13. The saponification value was found to be high and the acid value, Reichert Meissl number and unsaponifiable matter were low. The most striking property of the oil was its high acetyl value indicating the presence of hydroxylated acids in the neutral oil. In this respect, kalumpang oil more closely resembles castor oil than it does olive oil, as has been assumed by other investigators.

Separation of the saturated and unsaturated fractions in the neutral oil

The saturated and unsaturated fatty acids in the neutral oil were separated by the lead-salt-ether method of Gusserow and Varrentrapp as cited by Lewkowitsch (1921). It was found by repeated trials that the neutral oil was found to contain 87.36 ± 0.05 per cent liquid fatty acids and 7.07 ± 0.02 per cent solid or unsaturated fatty acids. The rather high percentage of unsaturated fatty acids accounts for the neutral oil being liquid at ordinary temperatures (table 4).

Examination of the unsaturated fatty acids

Table 5 shows some of the physical and chemical constants of the liquid acids.

It is interesting to note that the iodine value (Hanus) of the mixture of fatty acids is 87.05, a value below that of the theoretical for oleic acid. It would seem, therefore, that it is probably composed largely of acids having an iodine number of 90 and lower.

The solidifying point, neutralization value, saponification value and mean molecular weight were determined so as to have a general idea of the properties of the acids in the unsaturated fractions.

The method used in the separation and identification of the different fatty acids in the unsaturated fraction is that of Eiber and Muggenthaler (1903) as cited by Lewkowitsch (1922). The method is based on the differential solubilities of the bromo-compounds of

the acids in ordinary ethyl and petroleum ethers. This method was used by West and Montes (1921) and Soliven (1924) in their work on oils.

Table 6 shows six concordant trials. It was found by repeated trials that no precipitate was insoluble in ordinary ethyl ether. This shows the absence of linolenic acid and other acids belonging to this group, since the bromo-compounds of these acids are all insoluble in the solvent at ordinary temperature. The neutral oil, therefore, does not contain any acid belonging to the linolenic series.

When the ethyl ether was evaporated and the residue taken up with 150 cc, of low boiling point petroleum ether and the solution kept in the ice box for at least twenty-four hours no crystals were formed. After repeated trials, with no apparent success, some samples were kept in an ice box for several days so as to induce crystallization. Still no crystals were formed.

The resulting solution was then concentrated to about half its volume and the flasks again deposited in the ice box for several days. Still no precipitates were produced.

The solution was again concentrated further and still no precipitate was produced. With no less than thirty samples treated with no resulting precipitates it may be concluded that there are no crystals of tetrabromide, or if present, in such a small amount that it will not crystallize. It is possible that the amount of linoleic acid is so small that crystallization is impossible in the presence of a large amount of oleic acid or other acids of the oleic series. From the bromine content of the residue, however, the amount of linoleic acid mixed with it could be easily calculated.

The remaining solvent in the mixture was completely removed and the bromine content of the residue determined. It was found that the residue had an average bromine content of 35.44 $\pm$ 0.01 per cent. The theoretical bromine content of pure oleic dibromide is 36.18 per cent. The bromine content of the residue shows that it contained no bromo-derivative of linolic acid. Its absence might also be deduced from the observed low iodine value (87.05) of the liquid acids. Theoretically, the iodine value of pure oleic acid is 90.1, that of linolic acid 180.0. If linolic acid is ever present in the liquid acid its iodine value and bromine content of the brominated product ought to lie between the theoretical values. These observations, together with the failure to get crystals with repeated trials, prove the absence of acids belonging to the linoleic series in the liquid acid fraction and hence in the neutral oil.

Lewkowitsch (1921) observed that on heating the sample of oil he had to 240°C. it turned to a tough india-rubber like substance which remained elastic on exposure to the air. The resulting product

he obtained was insoluble in the usual solvents. He further stated that this was due to a process of polymerization similar to that observed in castor oil. He suspected the presence of a new fatty acid but its isolation was not attempted. A similar behavior was noted during the process of the preparation of the oil sample used in this study.

With this clue to work on, together with the unusually high acetyl value observed, this new fatty acid was suspected to be due to ricinoleic acid. Byk, as cited by Lewkowitsch (1921), stated that if a sample of ricinoleic acid was treated with sulfur, a plastic mass would be obtained. This plastic mass resembled india rubber in that it is elastic. This property has been found to be true only for ricinoleic acid.

Determination of ricinoleic acid

The method used in the determination of ricinoleic acid is based on the solubility of the calcium salt of ricinoleic acid and the insolubility of the calcium salt of oleic acid in warm alcohol. The exact procedure follows: To the accurately weighed sample of liquid acid alcoholic potash was added and the acid saponified in the usual way. The saponified sample was cooled and then slightly acidified with acetic acid using phenolphthalein as indicator. Then dilute potassium hydroxide was added to the mixture to make it slightly alkaline. A warm calcium oxalate solution was next added to the mixture in slight excess and the mixture allowed to stand for at least twenty-four hours. The precipitate was filtered and washed several times with cold water. It was then taken up with 95 per cent aldehyde free alcohol, refluxed and then filtered while hot. The residue was washed several times with warm alcohol. The filtrate and washings were collected. The residue contained the oleate of calcium and the filtrate contained the ricinoleate of calcium.

The filtrate and washings were treated with dilute hydrochloric acid to decompose the calcium salt, thus freeing the ricinoleic acid. The freed acid was then taken up with ethyl ether. The ethereal solution was washed with water till the washings were no longer acidic. The ethereal solution was then dehydrated with anhydrous sodium sulfate. The mixture was filtered and the ether removed. The residue was dried to constant weight. From the weight of the samples and the weight of ricinoleic acid obtained, the percentage of the latter was calculated.

The residue from the alcohol treatment was also treated with hydrochloric acid in the same way. The oleic acid in the residue was obtained and the percentage calculated.

In table 7 are shown the results of five trial tests. It may be readily seen from this table that the liquid acids were composed of 66.51 $\pm$ 0.08 per cent ricinoleic acid and 32.74 $\mp$ 0.13 per cent oleic acid. Thus, what had been considered as oleic acid by the bromo-derivative method was really composed of two distinct kinds of acids, both belonging to the oleic series. In this respect, kalumpang oil is similar to castor oil in that they both contain a fair amount of ricinoleic acid.

Table 8 shows the composition of the liquid acid fraction of kalumpang oil. The neutral oil has been found to contain 29.86 per cent of olein, 81.28 per cent of ricinolein and 7.07 per cent of solid acids.

The saturated acids

Some of the most important physical and chemical properties of the solid acids are given in table 9.

The solid acids were not analyzed as there are no proper facilities for this work in the department. The saturated acids isolated had some liquid acids mixed with the fraction, since the iodine value is rather high. At any rate, the corrected amount of the saturated acids could easily be calculated as is done elsewhere in this paper (table 4). The other constants were determined so as to ascertain the general property of the acids in the solid acid fraction.

SUMMARY AND CONCLUSIONS

1. The seed of kalumpang is composed of 41.66 per cent kernel and 58.33 per cent shell.

2. The kernel contains 51.30 per cent of a yellowish oil or 21.37 per cent on the basis of the whole seed.

Moisture	6.20 per cent
Ash	3.40 per cent
Ether extract	51.30 per cent
Crude fiber	2.34 per cent
Crude protein (N $\times$ 6.25)	23.91 per cent
Carbohydrates (by difference)	12.85 per cent

4. The ash from the kernel was found to have the following composition:

Insoluble matter and silica	0.27 per cent
Ferric oxide and alumina	2.49 per cent
Lime	4.58 per cent
Phosphoric acid anhydride	53.87 per cent
Potash	17.07 per cent
Sulfur trioxide	18.24 per cent
Undetermined (by difference)	3.48 per cent

5. The oil contains 87.36 $\pm$ 0.05 per cent unsaturated fatty acids and 7.07 $\mp$ 0.02 per cent of saturated fatty acids.

6. The liquid acids are composed of 66.51 $\pm$ 0.08 per cent ricinoleic acid and 32.74 $\mp$ 0.13 per cent oleic acid.

7. The conversion of the oil into an india rubber-like substance when heated is due to the presence of a fair amount ricinoleic acid in the oil.

LITERATURE CITED

BRILL, H. C., AND F. AGCAOILI. 1910. Philippine oil bearing seeds and their properties. II. Philippine Jour. Sci. Sec. A. **10**: 105–121.

JAMIESON, GEORGE S. 1932. Vegetables fats and oils. 444 p. New York: The Chemical Catalog Co., Inc.

LEWKOWITSCH, JULIUS ISIDRO. 1921. Chemical technology and analysis of oils, fats and waxes. Rewritten and enlarged; edited by George H. Warburton. Vol. 1. 6th. ed. xvii + 682 p., 59 fig. London: Macmillan and Co., Ltd.

LEWKOWITSCH J. I. 1922. Chemical technology and analysis of oils, fats and waxes. Rewritten and enlarged by George H. Warburton. Vol. 2., 6th. ed. xii + 959, p., 19 fig. London: Macmillan and Co., Ltd.

MERRILL, E. D. 1923. An enumeration of Philippine plants. Vol. 3. 628 p. Manila: Bureau of Printing.

PADILLA, SALVADOR, AND F. A. SOLIVEN. 1933. The proximate chemical composition of forty-five oil bearing seeds for possible sources of oil. The Philippine Agriculturist 22: 408–415.

ROBERTS, WILLARD, AND H. A. SCHUETTE. 1932. Determination of hydroxyl number of oils, fats and waxes. Jour. Indust. Engineer. Chem. Analytical Edition 4: 257–259.

SOLIVEN, F. A. 1924. The proximate chemical composition of palomaria seed, oil and resin. The Philippine Agriculturist 13: 65–79. *Pl. 1–2.*

WEST, AUGUSTUS P., AND ZOILA MONTES. 1921. The composition and oxidation of lumbang oil. The Philippine Jour. Sci. Sec. A; 18: 619–747.

TABLE 1

Showing the proximate composition of the kernels

CONSTITUENTS	FOUND IN THE PRESENT WORK	ANALYSIS BY	
		Brill and Agcaoili (1915)	Bolton and Jesson (1915)
	per cent	*per cent*	*per cent*
Moisture	6.20	—	—
Ash	3.40	3.90	—
Ether extract	51.30	51.78	52.00
Crude fiber	2.34	—	—
Crude proteins ($N \times 6.25$)	23.91	21.61	—
Carbohydrates (by difference)	12.85	—	—

TABLE 2

Showing the composition of the ash of the kernels

CONSTITUENTS	FOUND	CALCULATED ON THE BASIS OF ORIGINAL SAMPLE
	per cent	*per cent*
Insoluble matter and silica	0.27	0.092
Ferric oxide and alumina (Fe_2O_3 & Al_2O_3)	2.49	0.085
Lime (CaO)	4.58	0.156
Phosphoric acid anhydride (P_2O_5)	53.87	1.832
Potash (K_2O)	17.07	0.580
Sulfur trioxide (SO_3)	18.24	0.620
Undetermined (by difference)	3.48	0.118

TABLE 3

Showing the physical and chemical characteristics of kalumpang, castor and olive oils

CONSTITUENTS	FOUND IN THE PRESENT WORK	ANALYSIS BY BRILL AND AGCAOILI (1915)	ANALYSIS BY BOLTON AND JESSEN (1915)	CASTOR OIL JAMIESON (1932)	OLIVE OIL JAMIESON (1932)
Specific gravity	.9231 at 29°C.	.9254 at 30°C.		.958–.968	.9145–.9190 at 15°C.
Refractive index ...	1.4671 [a] at 29°C.	63.64 [b] at 40°C.		1.4790–1.4813 at 15°C.	1.4670–1.4675 at 25°C.
Iodine value (Hanus)	77.13	76.04	75.8	82–90	77–94
Saponification value .	215.04	212.01	193.8	177–187	185–200
Acid value	9.24	.30 per cc.N KOH			
Reichert Meissl number	1.86	2.10		0.2–0.3	0.3–0.6
Solidifying point (°C.)	–9 to –10			–10 to –12 [c]	
Acetyl value	109.10			143–150	4–12
Unsaponifiable matter	0.48			0.3–0.7	115–3.0

[a] Abbe refractometer.
[b] Butyro refractometer.
[c] Observation by Schaedler.

TABLE 4

Showing the separation of the solid acids from the liquid acids in kalumpang oil by the lead salt ether method

NO. OF TRIALS	WT. OF OIL USED	UNCORRECTED				CORRECTED			
		Liquid acids		Solid acids		Liquid acids		Solid acids	
	grams	*grams*	*per cent*	*grams*	*per cent*	*grams*	*per cent*	*grams*	*per cent*
1	17.0347	14.7476	86.58	1.2912	7.58	14.8576	87.22	1.1768	6.92
2	16.9708	14.5015	85.45	1.3882	8.18	14.6216	86.44	1.2411	7.49
3	16.9981	15.6760	87.51	1.2539	7.70	14.9855	88.16	1.1984	7.05
4	18.2201	15.6820	86.07	1.5159	8.32	15.8095	86.77	1.3584	7.62
5	18.1920	15.5760	85.62	1.3626	7.49	15.6815	86.25	1.2579	6.86
6	17.0339	15.0512	88.36	1.2469	7.32	15.1566	88.98	1.1413	6.70
7	9.4140	8.1247	86.40	.7015	7.59	8.1939	87.04	.6543	6.95
8	9.9813	8.5689	85.85	.7506	7.52	8.6318	86.48	.6867	6.89
9	11.5589	10.0771	87.18	.9132	7.90	10.1532	87.84	.8368	7.24
10	6.0074	5.2024	86.60	.4806	8.00	5.2426	87.27	.4524	7.53
11	10.1084	8.1802	86.86	.7137	7.06	9.7040	87.55	.6439	6.37
12	12.9406	11.3827	87.96	1.0365	8.01	11.4692	88.63	.9498	7.34
Average	—	—	86.73	—	7.51	—	87.36	—	7.07
Probable error of mean			±0.05	—	±0.05	—	±0.05	—	±0.02

TABLE 5

Showing the chemical and physical characteristics of the unsaturated fatty acids

CHARACTERISTICS	VALUE
Solidifying point (°C.)	–4° to –6°
Neutralization value	207.85
Mean molecular weight	270.38
Saponification value	221.17
Iodine value (Hanus)	87.05

TABLE 6

Showing the analysis of the liquid acids by the bromo-derivative method

EXPERIMENTS	LIQUID ACID USED	LINOLENIC HEXABROMIDE CRYSTALS	LINOLEIC HEXABROMIDE CRYSTALS	OLEIC DIBROMIDE	OLEIC ACID EQUIVALENT TO OLEIC ACID	OLEIC ACID	WT. OF BROMINE	BROMINE CONTENT
	grams	*grams*	*grams*	*grams*	*grams*	*per cent*	*grams*	*per cent*
1	8.4760	none	none	13.0805	8.3529	98.50	4.6043	35.19
2	8.0421	none	none	12.4768	7.9655	99.05	4.4347	35.55
3	9.2887	none	none	14.3439	9.1586	98.60	5.0552	35.24
4	10.6406	none	none	16.5149	10.5448	99.10	5.8743	35.57
5	8.9890	none	none	13.9714	8.9207	99.24	4.9824	35.66
6	9.1804	none	none	14.2199	9.0794	98.90	5.0395	35.44
Mean	—	—	—	—	—	98.93	—	35.44
Probable error of mean		—	—	—	—	+0.04	—	+0.01

TABLE 7

Showing the separation of ricinoleic and oleic acids in the liquid acids

NO. OF TRIALS	WT. OF LIQUID ACIDS USED	WT. OF RICINOLEIC ACID	RICINOLEIC ACID	WT. OF OLEIC ACIDS	OLEIC ACIDS
	grams	*grams*	*per cent*	*grams*	*per cent*
1	9.2793	6.0575	65.28	3.0909	33.31
2	11.6707	7.7750	66.62	3.8128	32.67
3	11.2934	7.5519	66.07	3.7065	32.82
4	4.5043	3.0183	67.01	1.4598	32.41
5	5.6056	3.7412	66.74	1.8218	32.50
Mean	—	—	66.51	—	32.74
Probable error of mean			±0.08		±0.13

TABLE 8

Showing the composition of the liquid fatty acids of kalumpang oil

CONSTITUENTS	FOUND	CALCULATED FROM THE ORIGINAL OIL	GLYCERINES IN THE ORIGINAL OIL
	per cent	*per cent*	*per cent*
Linolenic	none	—	—
Linoleic	trace	—	—
Oleic	32.74	28.60	29.86
Ricinoleic	66.50	58.70	61.28
Total	99.24	87.30	91.14

TABLE 9

Showing the physical and chemical characteristics of the solid fatty acids obtained from kalumpang oil

CHARACTERISTICS	VALUE
Melting point	57° to 60°C.
Solidifying point	50° to 54°C.
Neutralization value	234.39
Mean molecular weight	235.00
Saponification value	271.82
Iodine value	7.30

PRELIMINARY STUDIES ON THE MARCOTTAGE OF THE AVOCADO [1]

A. SAN PEDRO
Of the Department of Agronomy

WITH THREE TEXT FIGURES

There is a rapidly growing recognition of the merits of the avocado and an increasing enthusiasm in raising this exotic fruit on a commercial scale.

The avocado is an excellent example of a plant that does not come true to type when propagated by seed and for this reason it should not be grown in large numbers from seeds except when it is desired to produce new varieties. As early as 1901 it was demonstrated that the avocado can be budded when George B. Cellon grew it commercially by this method (Popenoe, 1927). In the Philippines, Wester (1911 and 1921), Cuitiong (1921), Gonzalez (1925) and Madjus (1926) successively showed that shield budding of this plant may be satisfactory under Philippine conditions. Gonzalez (1925) proved that it can also be cleft grafted. It can also be easily inarched (De Leon, 1930).

While the avocado can be propagated by shield budding, cleft grafting, bark grafting and inarching, these methods are too technical for the ordinary farmer to use. He prefers marcotting as this is a simpler way to propagate. But the avocado does not respond readily to marcotting, as ordinarily practiced. Some people have even concluded that the avocado cannot be marcotted. To make it possible for this first class food to be satisfactorily grown by the small farmer it is desirable to find a method of marcotting the avocado that will give good rooting results.

The experiments reported in this paper were conducted in the Division of Pomology of the Agronomy Department from the latter part of 1930 to September 15, 1934.

METHODS

The trees used for this work ranged in age from about 8 to 15 years. The branches used for the marcotting experiments were es-

[1] Experiment Station contribution No. 993. Received for publication October 26, 1934.
Read before the Los Baños Biological Club, October 25, 1934.

timated to be 3 to 5 years old and had a diameter of 11/2 to 3 centimeters.

The ringing method was followed in marcotting the branches. In this method a ring of bark about 4 to 7 centimeters long is removed, the length depending upon the size of the branch. The cambium layer is scraped with a knife to remove portions of the bark that remain on the wood.

Some branches were treated with potassium permanganate. The branches that were used as control received no treatment. After ringing, ordinary clay loam soil was used as rooting media. This

Fig. 1.—An unsuccessful avocado marcot six months after the first ringing. Note the protuberances located in the upper region of the completely callused ring.

was held in place around the wound by thin layers of coconut husk tied in place with No. 22 wire.

With the branches that were treated with potassium permanganate the following procedure was followed: One per cent potassium permanganate solution was prepared using tap water as solvent. Pieces of rags were soaked in this solution and wrapped around the ring. The rags were soaked three times a day during the treatment. After 48 hours the rags were removed and the rings covered with the rooting media. Some branches were allowed to callus for one month before they were provided with soil.

During the dry season the marcots were watered regularly twice a week. An ordinary bucket spray pump was found to be not only efficient but also economical for watering.

The marcots were inspected at least once a week for signs of rooting.

EXPERIMENTS AND RESULTS

Since the latter part of 1930, the writer has been marcotting avocadoes by the ordinary ringing method. From numerous trials not even a single marcot had rooted and for this reason the data

Fig. 2.—A very well rooted avocado layer. The scar encircling the origin of the roots indicates that it was wounded before rooting took place.

were not gathered until the end of 1933. In the early part of this year, however, more extensive trials were made and different treatments were tried. The records of these experiments were carefully kept.

All the available branches of three large avocado trees about 15 years old were marcotted from January 10–17, 1934. Tree No. 1 was variety Cyrus and at the time of marcotting the inflorescence buds, were beginning to bulge. The leaves were in dormant condition and

the bark slipped easily. Tree No. 2 was a seedling and was in almost the same condition as tree No. 1 except that the bark did not slip. Tree No. 3 was also a seedling and the inflorescence buds were out and some flowers were open when the marcotting was begun. The bark did not slip readily. There were 54 branches marcotted on tree No. 1, 72 on tree No. 2 and 56 on tree No. 3, making a total of 182 marcots. Of this number 48 were used as control, 69 were treated with potassium permanganate and 65 were callused for one month before being covered with soil.

As no roots had appeared after about 61 2 months, the marcots were opened and inspected on July 27, 1934. The results obtained

Fig. 3.—A very well rooted avocado marcot with half of the wrapping material and soil removed to show the origin of the roots. This marcot was ringed three times before it rooted.

are presented in table 1. The failure of all the marcots to root, irrespective of the treatments, was in all cases due to the complete bridging of the callus over the ring before rooting had time to take place (see fig. 1). This was precisely the cause of the failures experienced since 1930 in the writer's trials on marcotting avocado.

One interesting observation that struck the attention of the writer during the inspection of the marcots on July 27, 1934, was the presence of prominent protuberances about 2 to 3 millimeters in diameter and about 1 millimeter long, in the upper region of the

callused ring in almost all of the marcots. From their appearance and regularity of position on the callus it was suspected that those were rudimentary roots whose growth had been arrested during early development by the complete healing of the wound. To test this point, it was decided to renew the old rings by removing the callus, but leaving the upper portion which bore the protuberances. Tree No. 3 was saved for this purpose and the work was started on July 31, 1934. Trees No. 1 and 2 were killed. On September 4, 1934, just a little over a month after the second ringing, it was found that three branches had rooted. The roots were long enough to be clearly seen without removing the rooting media.

Another convincing evidence that the avocado can be marcotted was furnished by the following field observation. In the course of an exercise in pruning avocado plants, a student called the writer's attention to a branch which was pruned but which the student could not pull out of the ground. Examination proved that it was rooted (fig. 2). This branch originated from the main trunk of the plant at about 5 centimeters above the ground and took a north-south direction. It was crawling in habit and touched the ground at a distance of about 15 centimeters from the main trunk, the point at which it rooted. The writer is of the opinion that the strong westerly winds prevalent in the College orchard had caused a wound on the branch at the point of contact with the ground, thereby producing a condition quite similar to that of a layered branch.

At about the time of these observations a private grower told the writer that he had some rooted avocado marcots in his yard that he would like severed from the parent plant and potted. There were four marcots on his tree two of which were rooted, one had not yet struck root, and the fourth had died. One of the rooted marcots was cut from the tree. Figure 3 shows this marcot with its numerous roots. It can be seen that the origin of the roots occupy the same position as the protuberances shown in figure 3, suggesting the probability of the protuberances being roots. The owner of the tree said that the marcot shown in figure 3 had been ringed three times before it rooted, and the other rooted one, twice.

DISCUSSION

The peculiar response of the avocado to marcotting as recorded in this paper is very interesting and as far as the writer knows there is no case paralleling it in other fruit plants. The extraordinary rapid growth of the callus is particularly noteworthy. Whether or not the rooting would have taken place before the wound totally healed had the ring been made larger is at present unknown.

De Leon (1930) reported that "not all varieties of avocado root when marcotted". However, it has not yet been conclusively determined whether or not those varieties which "cannot be marcotted" are fast-callusing varieties that could be induced to root if more time were given before the healing of the wound was completed. The varieties studied in this report would have been considered as of the varieties that cannot be marcotted had a second ringing not been made.

Apparently, the marcotting of avocado has its complexities. In the studies that are in progress the effect of several factors upon rooting are under observation. These include the size of the ring, the stage of growth of the plant, the age of the wood, and the time of the year. Different varieties of avocado are included in the experiment. The results will be embodied in another paper when sufficient data are gathered. This paper is presented only to record some interesting observations in this line of work.

SUMMARY

The results of some preliminary studies on the marcottage of avocado are here reported. The experiments were started in the latter part of 1930 and are still in progress. It has been proved that while the avocado is difficult to marcot it is possible to make it root. One per cent potassium permanganate applied to the wound for 48 hours did not hasten rooting. Nor did allowing the ring to callus for a month before covering with soil help rooting.

It was suggested by the presence of prominent protuberances in the upper region of the ring that rudimentary roots had started to grow but that further development had been arrested by the complete healing of the ring. This inference led the writer to supplement the usual treatment by excising the callus below the protuberances. Rooting resulted in about a month after the second ringing. Hence, it seems that in the propagation of avocado by marcottage as ordinarily practiced, two operations are required to insure success.

LITERATURE CITED

CUITIONG, RUFINO C. The budding of the avocado. (Thesis presented for graduation from the College of Agriculture with the degree of Bachelor of Agriculture. 1921. Unpublished.)

GONZALEZ, LEON G. 1925. Some methods of asexual propagation of the avocado. The Philippine Agriculturist 13: 423–440.

LEON, JOSE DE. 1930. Inarching the avocado. The Philippine Jour. Agric. 1: 231–232.

MADJUS, ISIDORO L. Trial under Philippine conditions of certain recent methods of avocado propagation. (Thesis presented for graduation from the College of Agriculture with the degree of Bachelor of Agriculture. 1926. Unpublished.)

POPENOE, WILSON. 1927. Manual of tropical and subtropical fruits. xv + 474. New York: The Macmillan Company.

WESTER, P. J. 1911. The propagation of the avocado. The Philippine Agric. Rev. 4: 599–605.

WESTER, P. J. 1921. The avocado and its propagation. The Philippine Agric. Rev. 14: 127–204.

TABLE 1

Showing the effect upon rooting of avocado marcots of the application of potassium permanganate solution on the ring and of callusing the ring before wrapping

TREE NO.	NUMBER OF BRANCHES MARCOTTED ON JAN. 10-17, 1934			CONDITION OF THE MARCOTS ON JULY 27, 1934		
	Control	Treated with $KMnO_4$	Allowed to callus for one month	Control	Treated with $KMnO_4$	Allowed to callus for one month
1	7	17	30	No roots. All completely callused		
2	21	33	18	No roots. All completely callused		
3	20	19	17	No roots. All completely callused		
Totals . . .	48	69	65			

A COMPARATIVE STUDY OF TWO METHODS OF MANAGEMENT FOR FATTENING CATTLE [1]

RAFAEL ROCES, JR.

WITH TWO TEXT FIGURES

A large number of the cattle slaughtered in Manila are undersized and thin, the majority of them dressing below 100 kilograms, many as low as 80 kilograms and some down to even 60 kilograms. The quality of the beef from such animals is in many cases very poor and accordingly the price paid for the carcass is very low ranging from 20 to 30 centavos a kilogram (1933). Both Dr. Victor Buencamino, Director of the Bureau of Animal Industry and Representative Jose Sanvictores have pointed out that the production and sale of such animals, taking into consideration the numerous fees that are collected before their slaughter, cannot be profitable and in many cases is a losing proposition.

Such cattle come from distant places, the voyage having no inconsiderable bad effect on their condition. It is evident that to make the sale of these animals remunerative it is necessary that they be passed through a fattening process, to increase their weight, and improve the quality and consequently the price of the carcass. A number of cattlemen in the Islands have considered the possibility of offsetting the loss in flesh of cattle in transit by intensive feeding of the animals before slaughter. The late Mr. Marcos Roces, when President of the Philippine Live Stock Association, suggested to the Animal Husbandry Department of the College of Agriculture that it conduct trials bearing on this subject. Recognizing the importance of such an investigation, the study reported in this paper was conducted.

REVIEW OF LITERATURE

Sanchez (1923) concluded that bullocks fed copra meal as supplement to pasture made no more gain in weight than those on pasture alone.

Andouard (1901) claimed that on account of its low ash content cane molasses is superior to beet molasses for animal feeding.

[1] Thesis presented for graduation, 1934, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 436; Experiment Station contribution No. 994. Prepared in the Department of Animal Husbandry under the direction of Dr. Valente Villegas.

Giron (1922) states that a greater proportion of cane molasses than of beet molasses can be used in compounding feeds, because salts of the former do not have so laxative an effect as salts of the latter. He recommended as the best molasses feeds those in which molasses is mixed with the same quantity of various dry substances in a pulverulent stage.

Cross (1925) concluded that the use of molasses permits the securing of a daily economy of 25 to 40 per cent on the ordinary cost of rations and that molasses improves the health of animals.

Henry and Morrison (1916) state that molasses is especially useful in getting animals to clean up roughage which would otherwise be unpalatable.

Burns (*cited by* Henry and Morrison) in a 120-day trial, found that when three kilograms of molasses replaced an equal weight of corn grain the weight of the steer was slightly increased and less feed was required per hundred kilogram gain than when only corn was used.

Skinner and King (*cited by* Henry and Morrison) concluded from a 150-day trial that steers fed 1.25 kilograms of molasses, 4.95 kilograms of shelled corn and 1.5 kilograms of cotton seed meal gained .15 kilogram more per head daily than cattle fed 6.18 kilograms of shelled corn and 1.5 kilograms of cotton seed meal.

Lindsey (*cited by* Henry and Morrison) stated that a daily allowance of 1.3 to 1.7 kilograms of molasses per head can advantageously be fed to fattening steers.

Gerlaugh (1932) concluded that the calves in whose ration one kilogram of molasses was substituted for shelled corn made more growth than those that were full-fed on corn. The valuations placed on the feeds in this experiment show molasses was valued slightly higher than shelled corn.

Bernard (1925) states that the daily allowance of molasses for fattening cattle should not exceed five kilograms.

Cross (1933) claims that a mixture of 40 parts alfalfa, 20 parts corn, and 40 parts molasses is an excellent feed for steers. The animals fed the mixture were healthier and freer from digestive diseases than animals in whose ration there was no molasses.

Nelson (*cited by* Henry and Morrison) states that properly cured rice straw is an excellent feed for stock.

MacLaren (1923) claims that rice straw has about the same nutritive value as wheat straw and that its digestible nutrients are less than 40 per cent. When used to feed cattle it should be fed in combination with good concentrates rich in protein.

OBJECTS OF THE WORK

The objects of this work were:

(*a*) To compare two methods of management for fattening cattle: Pasturing for twenty-four hours versus pasturing in the daytime and housing animals in the barn at night and feeding with supplements of molasses, rice straw and copra meal.

(*b*) To determine the cost of fattening the same animals, by which the advisability or inadvisability of fattening these cattle for the slaughterhouse may be ascertained.

TIME AND PLACE OF EXPERIMENT

This feeding experiment was carried out in the Animal Husbandry Department of the University of the Philippines. The slaughter of the animals and marketing of the carcasses were made in Manila. The work was started in October, 1932 and ended in December, 1933.

MATERIALS AND METHODS

Materials

Animals. Twelve head of cattle, four steers and eight spayed heifers, with ages varying from one year and nine months to six years and eight months, were used. The different animals had Philippine, Indian Nellore and Hereford blood in varying proportions. The weights varied from 164 to 395 kilograms with an average of 274.3 kilograms for lot I, and from 200 to 368 kilograms with an average of 275.4 kilograms in lot II (table 1).

Pasture. A common pasture of 8 hectares in area was used for both lots. The vegetation on this pasture consisted of approximately 30 per cent cogon (*Imperata cylindrica* [Linn.] Beauv. Var. Koenigii [Retz] Benth.) and about equal amounts of Bermuda grass (*Cynodon dactylon* [Linn.] Pers), Paraguis (*Eleusine indica* [Linn.]), carabao grass (*Paspalum conjugatum* Berg.) and (*Desmodium triflorum* [Linn.] DC). There were also common weeds, sambong (*Blumea balsamifera* [Linn.] DC) and balatong aso (*Cassia tora* [Linn.]), which although abundant, did not seriously affect the grazing capacity of the pasture. There were a number of shade trees, mostly guava.

Feed. The animals in lot II were fed cane molasses, copra meal and rice straw as supplements to the pasture. The copra meal was obtained from the Philippine Manufacturing Co., at ₱0.25 a kilogram. The cane molasses was purchased from the Calamba Sugar Estate

at ₱0.004 a kilogram. The rice straw was baled in the College fields in February, 1931 at a cost of one centavo a kilogram. The bales were well-pressed and weighed on an average 25 kilograms each.

The chemical analysis of the supplements may be seen in table 2.

Barn. For feeding the supplements to the animals, stalls with concrete flooring and stanchion arrangements were used. The continuous mangers were well-partitioned to prevent the mixing of feeds of the different animals, which were placed side by side at feeding time. The barn has an iron roof but is open at the sides.

Methods

General plan of the experiment. Before the actual experiment was begun, preliminary work was undertaken at different times, (1) to accustom the animals to handling, particularly those which were to be fed in the barn; (2) to find a practical method of feeding the supplements; and (3) to ascertain the best proportion of the different supplements that the animals would eat.

The actual feeding work was run during the rainy season, from August to December, when the vegetation of the pasture was luxuriant and plentiful. The feeding period lasted 143 days.

Allotment of animals. Twelve cattle were divided into two lots of six animals each, each animal in lot I being paired with an animal of approximately the same blood composition, sex, age and weight in lot II. Thus, there were two steers and four heifers in each lot, the average age and weight being almost the same in the two lots. The distribution of animals in the two lots may be seen in table 1.

Management. Animals in lots I and II were kept in the same pasture and subjected to the same management from 6:00 a. m. to 6:00 p. m. Every afternoon the animals in lot II were taken to the barn where they were housed for the night and returned to the pasture the following morning. In the barn these animals were fed molasses and copra meal, which had been mixed in a can in proportions of two parts molasses to one part copra meal by weight. Besides this mixture, rice straw was given separately in the manger. The quantities of the supplements supplied to the animals daily were molasses, 2½ to 3 kilograms, copra meal, 1¼ to 1½ kilograms, and rice straw 1 to 1½ kilograms. The feeds were weighed before feeding and the next morning the amount left over was determined to find out the daily consumption of each feed. Animals in lot I were kept in the pasture all the time.

Salting and watering. Both lots were given a handful of salt weekly at weighing time. Fresh clear water was available in a creek on one side of the pasture.

Weighing. The twelve animals were weighed weekly on Tuesday afternoons after they had been watered. The initial and final weights were obtained by averaging the weights of the animals on three successive days at the beginning and the end of the experiment.

Slaughtering. The animals were slaughtered at the Manila Slaughterhouse on Azcarraga Street at about 11:00 a. m. on the last day of the experiment. Before leaving the College of Agriculture at 6:00 p. m. the previous day the animals were weighed. Two hours before the animals were slaughtered they were weighed again in Manila, the difference between the last weight taken in Los Baños and that taken in Manila representing the loss of weight in transit. Records of the dressed weights, quality of carcass and returns from each animal were kept. Two experienced judges were requested to determine the quality of the carcass of each animal. The dressing percentage was based on the live weight taken in Manila.

DISCUSSION OF RESULTS

Gain in weight

Table 4 is a summary table showing the average gain in weight, cost of feeds, marketing expenses and profit from lots I and II.

With the exception of animal No. 155 the animals in lot I lost weight, ranging from .6 kilogram in the case of animal No. 206 to 52.3 kilograms with animal No. 119. Animal No. 155 gained 2.3 kilograms. Computing the average of the six animals there was an average loss of 13.1 kilograms per animal. Animals of lot II, which received the supplements, made gains in weight ranging from 45.3 kilograms in the case of animal No. 192 to 90.9 kilograms with animal Nos. 154 and 214, the average for the lot being 67.5 kilograms per animal. Previous to the actual experiment, during the preliminary trials in summer, it was observed that there was a slight gain in weight in the animals of both lots in spite of the fact that grass was less abundant in the pasture at that time. The loss of weight in the animals of lot I during the actual experiment may therefore be ascribed not to any effect of feeding, but rather to the effect of unfavorable rainy weather. It may be mentioned in this connection that the animals in the pasture had no shelter other than that provided by shade trees.

The animals of lot II made steady gains in weight for 17 weeks after which there was no gain. This record was especially true of the older animals, which made practically no gains after 13 weeks, and actually lost in weight after 17 weeks. The younger animals were still gaining after 17 weeks, but only very little. When it is

considered that the daily consumption of the supplements was relatively greater toward the end of the experiment, it seems that it would have been more economical to have shortened the feeding period to 90 or 120 days, instead of running it 143 days.

Feed Consumption

Only the consumption of the supplements fed to animals of lot II will be discussed here. In general, the four heifers consumed approximately equal amounts of molasses, copra meal and rice straw. The two steers consumed almost equal amounts of each of the supplements, their consumption being about 50 per cent greater than that of the heifers. Of molasses the average consumption for the period by the heifers was 356 kilograms a head, or 2.48 kilograms a day. The steers consumed an average of 507 kilograms a head for the period or 3.54 kilograms a day. The average for the whole lot was 406.42 kilograms of molasses a head, or 2.84 kilograms a day. With copra meal, the heifers consumed an average of 185 kilograms a head, or 1.29 kilograms daily. The steers consumed an average of 278 kilograms a head or 1.94 kilograms per head daily. The average for the whole lot was 216.33 kilograms a head, or 1.51 kilograms daily. With rice straw, the consumption of the heifers was an average of 185 kilograms a head, or 1.29 kilograms daily; of the steers, the consumption was an average of 260 kilograms a head or 1.83 kilograms daily. The average consumption for the whole lot was 210.15 kilograms a head or 1.47 kilograms daily. Effort was made to make the animals consume more rice straw, but, they refused to eat it beyond the amounts here given. It was of interest to note that of the three supplements, the animals ate the rice straw first and usually it was consumed by about 8:00 p. m. However, additional amounts given were seldom eaten, although there was plenty of time during the night for the animals to eat more if they so desired.

Cost of feed

Pasture. The interest on the cost of pasture land together with the land tax for the period for which the experiment was conducted was charged to the animals of both lots (I and II). But since the animals in lot II occupied the pasture only half of the time, they were charged only half the amount charged the animals in lot I. Thus the amount charged against each animal of lot I is ₱2.14 and that charged against each animal of lot II is ₱1.07.

Supplements. The cost of molasses consumed by all the animals in lot II was ₱9.75 or ₱1.63 an animal. With copra meal the total

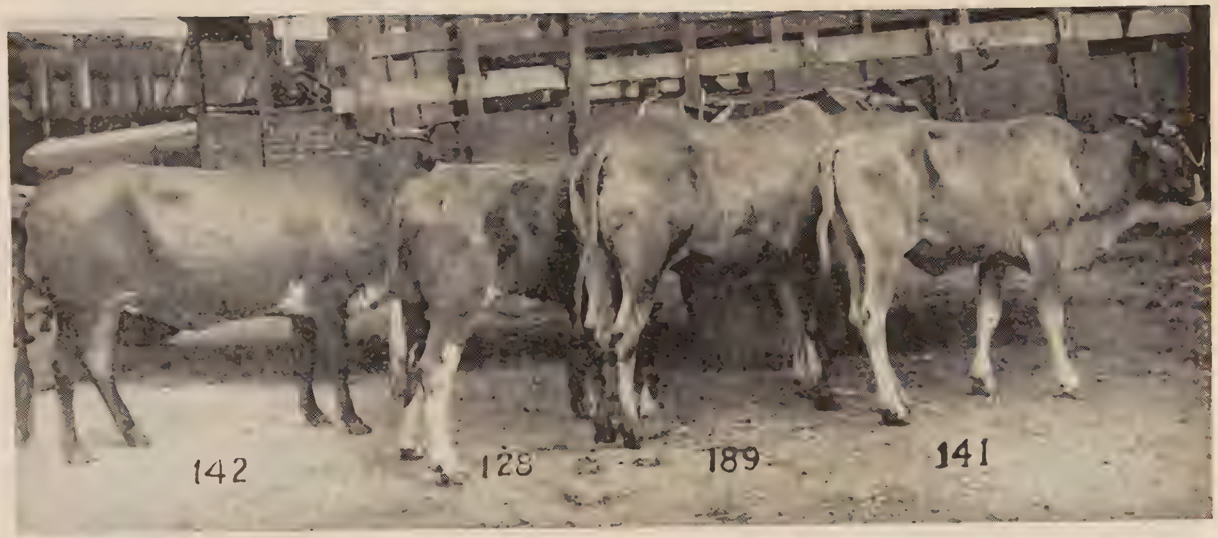


Fig. 1.—Showing at end of the experiment, for comparison, the size and condition of animals Nos. 142 and 189 of lot II and animals Nos. 128 and 141 of lot I. No. 128 was paired with No. 142 and No. 189 with No. 141.

cost was ₱32.46 or ₱5.41 an animal. The cost of rice straw consumed by all the animals was ₱12.61 or an average of ₱2.10 an animal. The total cost of feed supplements was ₱54.82 or an average of ₱9.14 an animal.

The total cost of feed for animals in lot I was ₱12.84 or an average of ₱2.14 an animal. The cost of feed for animals in lot II was ₱54.82 for the supplements and ₱6.42 for the pasture or a total of ₱61.24, making an average of ₱10.21 an animal.

Cost of feed per 100 kilograms gain. The cost per 100 kilograms gain in lot II varied from ₱10.22 for the youngest animal, No. 214, to ₱27.85 for the oldest animal, No. 129, with an average of ₱15.13. The young heifers were, in general, more economical feeders than the older steers, which is to be expected.

Barn charges

Inasmuch as the feeding of the supplements required the use of the barn, as previously stated, a charge of ₱3.09 was made against each animal for barn use during the experiment. This charge, according to Sarao (1929) included 6 per cent interest on the original cost of the barn, 3.3 per cent for depreciation, 2 per cent for repairs, 0.25 per cent for taxes, and .5 per cent for insurance, the total of these items was 12.05 per cent a year on the original cost of the barn which was ₱800.00. Thus the charge for the use of the barn for 143 days was ₱18.54 or ₱3.09 for each animal.

Labor charges

There was no labor required in the care of animals of lot I. The labor for animals of lot II consisted of driving the animals from the pasture to the barn, and back to the pasture, feeding of the supplements and cleaning of the stalls. This work required one hour and a half a day. At the local rate of 10 centavos an hour, the labor charges for animals of lot II for 143 days was ₱21.45 or an average of ₱3.58 an animal.

Shrinkage

The fatter animals, in general, suffered the greater shrinkage. The animals in lot I, which were the thinner group lost an average of 3.3 kilograms a head. while the animals of lot II lost an average of 6.3 kilograms. There was no shrinkage with animal No. 208 in lot I. The rest, however, showed shrinkage of from 1.5 to 7.7 kilograms. The maximum shrinkage, 7.7 kilograms, was made by animal No. 155. In lot II the minimum shrinkage was with animal No. 189 which lost 1.0 kilogram and the maximum shrinkage was with animal No. 154 which lost 11.3 kilograms.

Fig. 2.—Showing for comparison the size and condition of carcasses of animal No. 189 of lot II and of animal No. 141 of lot I with which it was paired.

Dressing percentage

The dressed weight of animals in lot I varied from 69 kilograms, animal No. 206, to 199 kilograms, animal No. 155; the dressed carcasses of animals in lot II weighed from 119 kilograms, animal No. 192, to 219 kilograms, animal No. 154. Each animal in lot II had a greater dressed weight than the one with which it was paired in lot I. The average dressed weight of animals in lot I was 120.5 kilograms, in lot II, 169.7 kilograms, giving a difference of 49.2 kilograms in favor of lot II.

The dressing percentage of lot I varied from 43.1 per cent, animal No. 206, to 51 per cent, animal No. 155, with an average of 46 per cent; the animals of lot II had dressing percentages ranging from 48.7 per cent, animal No. 142, to 52.6 per cent, animal No. 214, with an average of 50.2 per cent.

Quality of the carcass

According to the judges who passed judgment on the carcasses of the animals, those of lot I were judged as from "6ª clase", in the case of animal No. 206 to "1ª clase", in the case of animals Nos. 119, 155 and 128; those of lot II were all of the "1ª clase", the carcass of animal No. 189 being "1ª extra". It is interesting to note that the greatest difference in the quality of beef between animals of lot I and lot II as affected by supplementary feeding was found in the younger animals. The carcasses of the three youngest animals in lot I were classified "4ª, 6ª and 5ª clase", respectively, while the carcasses of animals of lot II were classified "1ª extra, 1ª and 1ª", respectively. The older animals of each lot had carcasses that were all classified "1ª clase".

Marketing expenses

The marketing expenses are clearly presented in table 3.

Truckage. Two trucks were used to take the animals from the College of Agriculture to Manila, each charging ₱15.00 or a total of ₱30.00.

Veterinary inspection fees. Twenty centavos a head were charged for the Government inspection of the carcasses so as to prevent the sale of diseased carcasses and such parts as were unfit for food. The total charges for each lot was ₱1.20.

Slaughterhouse fees. A fee of 5 centavos a kilogram of dressed beef was charged by the City of Manila for the use of the slaughterhouse. Thus, the total charges for animals of lot I were ₱36.15 or an average of ₱6.03, for lot II, ₱50.90, or an average of ₱8.48 an animal.

City delivery fees. Thirty centavos per side or sixty centavos per animal were charged for the transportation of the beef from the slaughterhouse to the market. Only government trucks are permitted to take the carcasses to the different markets of the city. The total of delivery charges for the animals of each lot was ₱3.60.

Butcher's fee. Five persons butchered these cattle charging a fee of ₱1.50 per head, making the total charges ₱9.00 for each lot. It took the butchers about one hour and a half to dress all the carcasses.

Agent's commission. The marketing of these animals was done through the Philippine Live Stock Association, which charges a commission of three centavos a kilogram, dressed weight. This association supervises the butchering and sale of the animals and acts as a credit institution because it pays the cattleman much sooner than the retailers, to whom the carcasses are sold, pay the association. The commission charges for animals of lot I totaled ₱21.69, and for animals of lot II, ₱30.54.

Total marketing expenses. The total marketing expenses for lot I were ₱86.64 or an average of ₱14.44 per animal; for lot II, ₱110.24 or an average of ₱18.37 per animal.

Total proceeds from animals

Beef. The returns from the beef of animals of lot I ranged from ₱17.20, in the case of animal No. 206 to ₱69.60 for animal No. 155, the average being ₱38.25 an animal. The returns from the beef of animals of lot II varied from a minimum of ₱41.60, in the case of animal No. 192 to ₱77.90 with animal No. 129, the average being ₱60.24 an animal. Thus lot II averaged ₱21.99 an animal more than lot I.

Considering the amount of dressed beef obtained from each animal it follows that the prices paid per kilogram of beef from animals of lot I ranged from 26 centavos in the case of animal No. 206, to 35 centavos with animals Nos. 119 and 155 giving an average of 31 centavos. The prices paid per kilogram for the carcasses of animals of lot II ranged from a minimum of 35 centavos with animals Nos. 154, 142, 192 and 214 to 37 centavos for animal No. 129, with an average of 36 centavos. Thus, on an average, the price received per kilogram was 5 centavos more for lot II beef than for lot I.

It will be noted that in some cases the actual prices paid per kilogram for the carcasses of the animals do not exactly conform to the prices expected from the classification of the quality of the beef. Such exceptions are probably due to the factors that enter in the retailing of the carcasses, such as bargaining, etc.

Offal. The prices paid for the offal was five centavos per kilogram based on the dressed weight of the animals. The returns from the offal of animals in lot I ranged from ₱3.45 with animal No. 206 to ₱9.95 with animal No. 155, with an average of ₱6.03 an animal. The offal of animals of lot II brought returns ranging from a minimum of ₱5.95, with animal No. 192, to a maximum of ₱10.95 with animal No. 154, with an average of ₱8.48 an animal.

Hide. The price paid for the hide was 3 centavos per kilogram based on the dressed weight of the animals. Accordingly, the returns from the hide of animals of lot I varied from ₱2.07 with animal No. 206 to ₱5.97, with animal No. 155; the returns from the hides of animals in lot II varied from ₱3.57 in the case of animal No. 192 to ₱6.57 with animal No. 154. The average returns for the hides of animals of lot I were ₱3.61; of lot II, ₱5.09.

The total proceeds from animals of lot I were ₱287.34 or an average of ₱47.89, from animals of lot II, a total of ₱442.89 or an average of ₱73.81 an animal. That is, the proceeds from lot II were ₱25.92 per animal more than from lot I.

Net returns

The net returns for each animal of lot I after deducting feeding, barn, labor and marketing expenses varied from ₱6.14 in the case of animal No. 206 to ₱68.94 with animal No. 155, the average being ₱31.32 an animal. With animals of lot II the net returns varied from ₱17.08 with animal No. 192 to ₱57.15 with animal No. 129, the average being ₱38.56 an animal. With one exception, the animals in lot II brought greater net returns than the animals paired with them in lot I. The exception was animal No. 154 of lot II, the net returns from which were ₱12.55 less than that from No. 155 of lot I the animal paired with it. This exception may be explained by the fact that although animal No. 154 made a gain of 88.6 kilograms more than animal No. 155 during the experiment, animal No. 155 at the beginning of the experiment was in very good condition and maintained this with a slight gain up to the end of the experiment. Accordingly, the quality of beef and dressing percentage of animal No. 155 was as good as that of animal No. 154. Because of this, the gain in weight made by animal No. 154 was not enough to offset the greater cost of feeding, marketing, labor and barn expenses. With the exception of animal No. 154 the animals of lot II showed a profit of from ₱3.90 in the case of animal No. 142 to ₱20.30 with animal No. 189. Taking into account the loss of ₱12.55 in the case of animal No. 154 there was an average net return of ₱7.25 more from

the animals of lot II than from the animals of lot I. This difference represents the average profit made by the second method of management, that is, pasturing in the daytime, and keeping the animals in the barn at night, with feeding of supplements of copra meal, molasses and rice staw.

SUMMARY AND CONCLUSIONS

From the results of this experiment the following summary and conclusions are presented:

1. Two steers and four spayed heifers were compared with another lot of cattle which were the same in sex and similar in age, breeding and weight in an experiment in which lot I was pastured 24 hours a day and lot II was pastured in the daytime and kept in the barn at night and fed with supplements of molasses, copra meal and rice straw.

2. The feeding period lasted for 143 days and was carried out during the wet season of 1933.

3. The pasture consisted of about one-third cogon and equal amount of *Cynodon dactylon, Eleusine indica, Paspalum conjugatum* and *Desmodium triflorum.*

4. The average consumption of supplements by animals in lot II was copra meal, 1.51 kgm., molasses, 2.84 kgm., and rice straw, 1.47 kgm. per head, daily.

5. Animals of lot I which were kept in the pasture all the time, lost an average of 13.1 kgm. a head during the experiment.

6. The animals of lot II which were kept in the barn at night and received molasses, copra meal and rice straw as supplements to pasture made an average gain of 67.5 kgm. an animal.

7. The pasture charges for animals of lot I amounted to ₱2.14 a head.

8. The pasture cost for animals of lot II was ₱1.07 a head; the cost of supplements a head was copra meal, ₱5.41, molasses, ₱1.63, and rice straw, ₱2.10, making the total charges including pasture ₱10.21.

9. The cost per 100 kilograms gain of animals in lot II was ₱15.13 a head.

10. Animals of lot I suffered an average loss of 3.3 kilograms a head during transit from the College of Agriculture to Manila, a distance of about 70 kilometers, those of lot II an average of 6.3 kilograms a head.

11. The average dressed carcass of animals in lot I was 120.5 kilograms a head, that of lot II, 169.7 kilograms. Accordingly,

animals of lot I, had a dressed average of 46 per cent and those of lot II, 50.2 per cent.

12. Carcasses of animals of lot I were adjudged from "6ª clase" to "1ª clase", while those of animals of lot II were all of the "1ª clase", one of which was "1ª clase extra".

13. The average total marketing expenses of animals in lot I were ₱14.44 a head; of lot II, ₱18.37. The expenses included truckage, veterinary inspection fee, slaughterhouse fee, City delivery fee, butcher fee, and agent's commission.

14. The total proceeds per head of animals of lot I were ₱47.89, of lot II, ₱73.81, giving a difference of ₱25.92 in favor of animals of lot II. The proceeds of lot I, were distributed as follows: carcass, ₱38.25; offal, ₱6.03; and hides, ₱3.61; those of lot II were distributed as follows: carcass, ₱60.24, offal, ₱8.48 and hide, ₱5.09.

15. The net returns for animals of lot I after deducting feeding, barn, labor and marketing expenses was an average of ₱31.31 per animal, for lot II, ₱38.56 or a difference of ₱7.25 per animal in favor of lot II.

LITERATURE CITED

ANDOUARD, A. P. 1901. Sugar cane molasses. Loire—Inference Bulletin Station 39–42. *Cited in the* U. S. Dept. Agric. Exper. Sta. Rec. **13**: 1901.

BERNARD, M. 1925. Methods of using molasses for stock feed. The Planter and Sugar Manufacturers **76**: 367.

CROSS, W. E. 1925. El uso de la melaza en la alimentación de los animales. Revista industrial agricola de Tucuman 15: 129–145. *Cited in* The Planter and Sugar Manufacturers **76**: 267.

CROSS, W. E. 1933. La melaza como alimento para animales. La Hacienda 12: 342.

GERLAUGH, P. 1932. Molasses for fattening cattle. Ohio Agric. Exper. Sta. Bimonthly Bull. **13**: 154–178.

GIRON, P. 1922. Value of molasses as a feed. Sugar **24**: 381.

HENRY, W. A., AND F. B. MORRISON. 1916. Feeds and feeding. 16th. ed. x + 691. Ithaca, New York: Henry and Morrison Co.

MACLAREN, J. R. 1933. La paja de arroz como alimento para animales. La Hacienda **28**: 246.

SANCHEZ, A. C. 1923. Experiments on draft cattle. The Philippine Agriculturist **12**: 173–179.

SARAO, FELIX B. 1929. The cost of producing milk in the College of Agriculture. The Philippine Agriculturist **18**: 427–438.

TABLE 1

Showing sex, breeding, age and weight of animals in lots I and II

	ANIMAL NO.	SEX	BLOOD COMPOSITION	AGE	WEIGHT
					kgm.
Lot I Pasture 24 hr.	119	Male, castrated	3/4 P–1/4 H	6 yr. 8 mo.	395.4
	155	Male, castrated	1/8 P–5/8 N–1/4 H	4 yr. 5 mo.	395.4
	128	Female, spayed	1/8 P–1/8 N–3/4 H	6 yr. 4 mo.	262.0
	141	Female, spayed	1/4 P–3/4 N	5 yr. 2 mo.	217.8
	206	Female, spayed	1/8 P–3/4 N–1/8 H	2 yr. 1 mo.	163.6
	208	Female, spayed	1/8 P–1/2 N–3/8 H	1 yr. 3 mo.	211.7
Average				4 yr. 2 mo.	274.3
Lot II Pasture in the daytime; barn at night with supplement of molasses, copra meal and rice straw.	129	Male, castrated	3/4 P–1/4 H	6 yr. 3 mo.	368.1
	154	Male, castrated	1/8 P–5/8 N–2/8 H	4 yr. 5 mo.	355.4
	142	Female, spayed	1/4 P–1/2 N–1/4 H	5 yr. 3 mo.	262.7
	189	Female, spayed	1/4 P–3/4 N	3 yr.	245.4
	192	Female, spayed	1/8 P–3/8 N–1/2 H	2 yr. 10 mo.	220.6
	214	Female, spayed	3/4 N–1/4 H	1 yr. 9 mo.	200.0
Average				3 yr. 11 mo.	275.4

TABLE 2

Showing chemical analysis of molasses, copra meal and rice straw [a]

	MOLASSES	COPRA MEAL	RICE STRAW
	per cent	*per cent*	*per cent*
Moisture	29.91	12.83	7.10
Ash	5.39	7.26	20.87
Crude protein	1.22	17.50	2.67
Crude fiber	—	15.73	28.22
Carbohydrates	63.01	40.91	39.70
Fat	0.47	5.77	1.44

[a] Analyzed in Experiment Station Section of the Department of Agricultural Chemistry.

TABLE 3

Showing expenses and returns in lots I and II

	LOT I	LOT II
	pesos	*pesos*
Returns:		
Beef	229.50	361.45
Offal	36.15	50.90
Hides	21.69	30.54
Total	287.34	442.89
Average	47.89	73.81
Expenses:		
Veterinary inspection fees @ 20¢ a head	1.20	1.20
Truckage (Los Baños to Manila)	15.00	15.00
Slaughterhouse fees @ 5 ¢ a kgm. dressed weight	36.15	50.90
City delivery	3.60	3.60
Butcher's fee @ ₱1.50 a head	9.00	9.00
Marketing commission @ 3 ¢ a kgm. dressed weight	21.69	30.54
Total	86.64	110.24
Average	14.44	18.37
Net proceeds	200.70	332.65
Average net proceeds	33.45	55.44

TABLE 4

Showing average gain in weight, cost of feeds, marketing expenses and profit from lots I and II

	LOT I	LOT II
Initial weight	274.3 kgm.	275.4 kgm.
Final weight	261.2 "	342.9 "
Gain or loss	–13.1 "	67.5 "
Dressed weight	120.5 "	169.6 "
Dressing percentage	46.0	50.1
Quality of carcass	6 a to 1 a	1 a to 1 a extra
Price of beef per kgm.	₱0.31	₱0.36
Returns per animal:		
Beef	₱38.25	₱60.24
Offal	6.03	8.48
Hides	3.61	5.09
Total returns	47.89	73.81
Consumption of feed:		
Molasses, 2.84 kgm. a day	—	406.42 kgm.
Copra meal, 1.51 kgm. a day	—	216.33 "
Rice straw, 1.47 kgm. a day	—	210.15 "
Cost of feed consumed:		
Molasses, 406.42 kgm. @ 0.4 ¢	—	₱1.63
Copra meal, 216.33 kgm. @ 2.5 ¢	—	5.41
Rice straw, 210.15 kgm. @ 1 ¢	—	2.10
Average cost of pasture	₱2.14	1.07
Cost of feed and pasture	—	10.21
Cost per 100 kgm. gain	—	15.13
Gain over cost of feed and pasture	45.75	63.60
Barn charges	—	3.09
Labor	—	3.58
Average marketing expenses	14.44	18.37
Net returns	₱31.31	₱38.56
Average profit from feeding supplements	—	7.25

STUDIES ON THE STORAGE TEMPERATURE REQUIREMENTS OF THE CHICO, ACHRAS ZAPOTA LINN.[1]

JOSÉ H. CAMPO

WITH ONE TEXT FIGURE AND ONE CHART

The chico, *Achras zapota* Linn. is an important fruit which grows well in the Philippines. When ripe, this fruit is esteemed for its good flavor and pleasant aroma. When immature, it contains a milky latex, very astringent to the taste, so that ordinarily the fruit is not eaten until fully ripe.

According to the report of the Bureau of Plant Industry, in 1929 there were in the Philippines about 227 hectares planted to chico. These trees bear about 3,950,000 fruits, market value estimated at about ₱26,460.00.

Like most fruits, the chico is perishable. Its market life when ripe is only two or three days, hence it cannot be shipped to distant markets. Any contribution to the knowledge of prolonging the market life of this fruit should be of great economic importance.

Of the different methods of storing fresh perishable products, cold storage has proved the most satisfactory. Its use will increase the life of fruits or vegetables two or more times.

The writer was not able to find much work on the storage temperature requirements of the chico. In the work of Gonzalez (1931), in connection with his study on the respiration of the chico, it was found that the fruit placed on ice and then removed to room temperature (27° to 30°C.) ripened normally, provided they were not left at O°C. for over five days. Cheema and Gandhi (1925) who worked in India found that the green chico fruits behaved normally at 40°F. The skin of the fruits did not become pitted, as was commonly observed with mango exposed to low temperatures. Lowering of temperature to below 40°F. made the chico hard and ripening was irregular even when removed from cold storage. Cheema and Gandhi were able to keep green chicos at 40° to 50°F. for a month in good condition, the fruits ripening normally after they were removed from cold storage.

---

[1] Thesis presented for graduation, 1932, with the degree of Bachelor of Agriculture from the College of Agriculture No. 437; Experiment Station contribution No. 995. Prepared in the Department of Agronomy under the direction of Dr. L. G. Gonzalez.

The objects of the present work were: (*a*) to find the influence of different storage temperatures on the keeping and ripening qualities of chico fruits; (*b*) to determine some of the more important physico-chemical changes in the fruit; and (*c*) to determine the freezing point of the sap.

These studies were conducted in the Pomology Division of the Department of Agronomy, College of Agriculture, University of the Philippines. The work was begun in November, 1930 and closed in May, 1932.

MATERIALS AND METHODS

Fruits at three stages of maturity were used in the experiment; namely, green but mature, turning and ripe. The fruits were obtained in the towns of Los Baños and Cabuyao, Laguna, and from the trees in the College orchards. In picking the fruits, a pair of nippers was used to cut the stem and care was taken not to bruise or wound them. The fruits were washed carefully and air-dried before using them in the experiment. Within ten hours after picking, the fruits were placed in the refrigerating apparatus and the experiment was begun.

A five gallon kerosene can with top removed was used for the refrigeration chamber in the experiment (fig. 1). The bottom of the can was soldered to the bottom of another can made of galvanized iron and measuring, 44 × 44 ×44 centimeters; the top was open. The distance between the two cans measured 101/2 centimeters. The galvanized iron can served as a water bath and the kerosene can as the storage chamber. A small iron tube was soldered to the bottom of the outer can for the purpose of draining off the water during the temperature adjustments. A layer of sawdust was put 12 centimeters thick around the larger can to serve as insulator. A wooden cover 21/2 centimeters thick was fitted to the top of the kerosene can. The whole container was insulated with thick paper and two wooden lids. By using Chapman's suction pump the air was kept circulating through the chamber. San Pedro (1932) used this apparatus in his studies on the lanzon.

Five temperatures were used; namely, 0°, 10°, 15°, 20°, and 27.5°C. Maximum variations of the temperatures were as follows: 10° to 13°C.; 15° to 17.5°C.; 20° to 22°C.; and 27.5° to 28.5°C.; the 0°C. was maintained unchanged by completely filling the bath with crushed ice and draining off the water once a day. Temperatures were adjusted three times a day, in the morning, at noon and in the afternoon. The greatest change in temperature was found in the morning.

The 375 chicos used were divided into lots of 25. Five lots for the green fruits, five for the mature, and five for the ripe were used. One lot of green, one of the mature and one of the ripe were placed in each of the five storage chambers; that is, green, mature and ripe fruits in temperature 0°; in 10°; in 15°; in 20°; and in 27.5°C.

The fruits placed in the storage chambers were laid on a rack made of fine wire gauze supported by galvanized iron. These racks

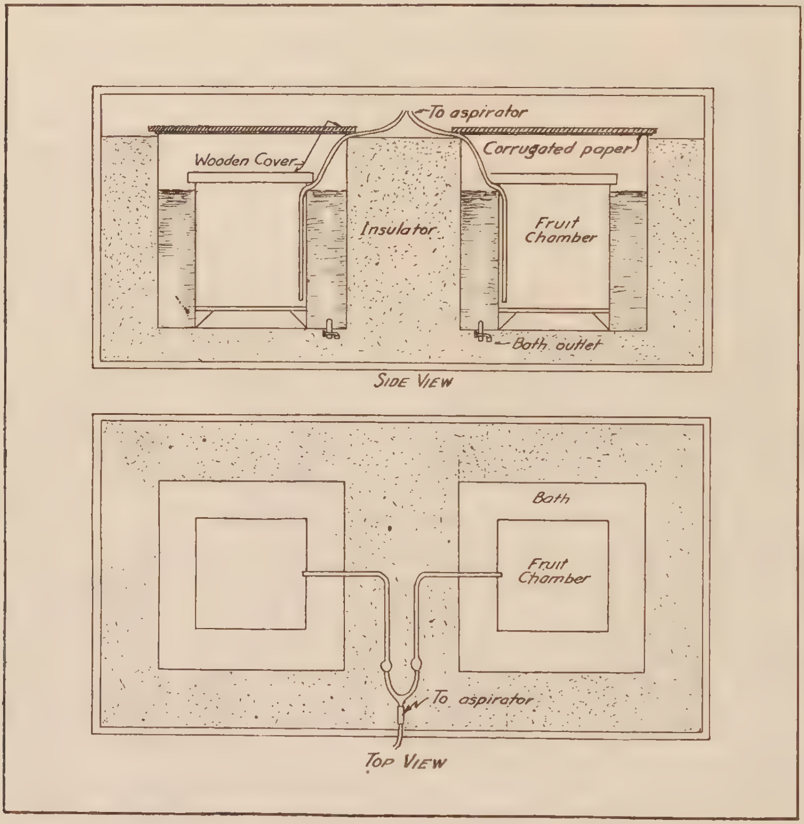


Fig. 1.—Showing apparatus used in storage experiments.

kept the fruits separated and facilitated the daily inspection. Samples of green and turning fruits were taken from the 0° and 10°C. storage chambers every day, placed at room temperature and observed for their ripening quality. The opinion of various persons regarding flavor and texture changes in the fruit was obtained. *Color Standard and Color Nomenclature* by Ridgway (1912) was used in checking color changes in the fruit.

The freezing point of the juice of the fruit was measured by the Beckmann thermometer. The juice of the fruit was extracted with a hand press. San Pedro (1932) described this press as "consisting of two blocks of molave (*Vitex pubescens* Vahl Symb.). The larger block had a round hole 101/2 centimeters in diameter, 9 centimeters deep at the center into which the smaller block was made to fit, leaving about 2 millimeters of surrounding space." The ripe fruits were frozen in tightly stoppered cans immersed in ice and salt mixture, then thawed and wrapped in clean dry cheese cloth. The wrapped tissue was placed on the large block, the smaller block put in place and then pressed by means of a benchscrew. The juice flowed to the outside through the smaller groove on the side of the block. The juice was collected and placed in a 25 cc. test tube; a thermometer was put in this tube. To provide a double wall this test tube was put in a 4 cc. test tube. Salt and ice placed in an 18 × 7 cm. glass jar insulated with 4 cm. layer of sawdust was used for freezing. The freezing point of distilled water was determined every now and then for purposes of computation.

For correction of freezing point of the sap the following formula suggested by Harris and Gortner (1914) was used: $\triangle = \triangle' - (0.0125)\mu\triangle'$ where $\triangle$ is the corrected freezing point, $\triangle'$ the observed freezing point, 0.0125 heat of liquefaction of ice and μ, amount of super-cooling. Unless otherwise stated figures presented in this paper were corrected for super-cooling.

Heinicke's method (1924) for the determination of the catalase activity was followed. The fruits were cut longitudinally and 2 grams of the sliced portion were used. The sample was placed in a porcelain mortar and a little purified quartz sand and a few drops of rain water, just enough to produce a thin pasty covering for the sample, were added. The mixture was ground until a pasty mass was produced. Water was added to make the total volume of water 10 cubic centimeters. The suspension was placed in a flask, and corked. The flask was left at room temperature for 24 hours before catalase determination was made. The apparatus used for the catalase activity determinations consisted of a leveling bulb supported by a ring clamp. The stem of the bulb was connected to one end of a burette. A T-tube was inserted in a one-hole rubber stopper fitted to the mouth of the burette. The other stem of the T-tube was provided with a pinch-cock. The other end of the T-tube was connected with a rubber tube to a glass tube which was inserted in a one-hole rubber stopper. This was fitted to the opening of the stem end of a

Y-shaped reaction tube.[2] With a 2 cc. pipette, 4 cc. of the well-stirred suspension was placed in one arm of the reaction tube and with another pipette, 2 cc. of fresh hydrogen peroxide (3 per cent) was placed in the other arm. The reaction tube was connected to the burette with the rubber stopper and immersed in the water bath which was kept at constant temperature of 30°C. The level of the water in the burette was adjusted to the 0 mark by opening the pinch-cock. After one minute of immersion the Y-tube was rotated in such a way that the suspension and the hydrogen peroxide mixed together and flowed from one arm to the other at the rate of about 60 complete swings per minute. A watch was used in recording the time required to liberate first, second and third cubic centimeters of oxygen.

EXPERIMENTS AND RESULTS

Storage studies. Five storage temperatures were employed. In each temperature, were placed 15 lots of 25 fruits each. Three stages of maturity were selected, alloting 5 lots to each stage of maturity. A total of 1875 fruits were used in this part of the experiment. The results of the work are shown in table 1.

Freezing point of the juice of the frozen and unfrozen fruit. Dixon (1914), Harvey (1918), Carrick (1924) and Gonzalez (1927) found significant differences between the freezing point of the juice of frozen and unfrozen tissues of certain plants. To check this point with the chico, experiments were conducted in which half of the fruit was previously frozen and the other half not, before extracting the juice for determining the freezing point. The results of the experiment are shown in table 2. Table 3 shows more freezing point determinations from ripe fruits previously frozen.

Catalase activity of the different parts of the fruit. By using turning chicos the point of possible localization of catalase was checked. The fruits were cut cross-wise into three equal parts designated as the stem end, median region and stigmatic end. Five samples from these parts, using triplicate determinations, were made. The result of this work is shown in table 4.

Influence of maturity on catalase activity. The results of the determination of the catalase activity of green, turning and ripe chicos are shown in table 5.

Influence of temperature on the catalase activity of the fruit. The catalase activity of the green, turning and ripe fruits stored

[2] For illustration of this apparatus *see* THE PHILIPPINE AGRICULTURIST, Volume XXI, No. 8, p. 535.

at 0°, 10°, 15°, 20°, and 27.5°C. was determined after five days in storage. The details and results of the experiment are shown in table 6 and chart 1.

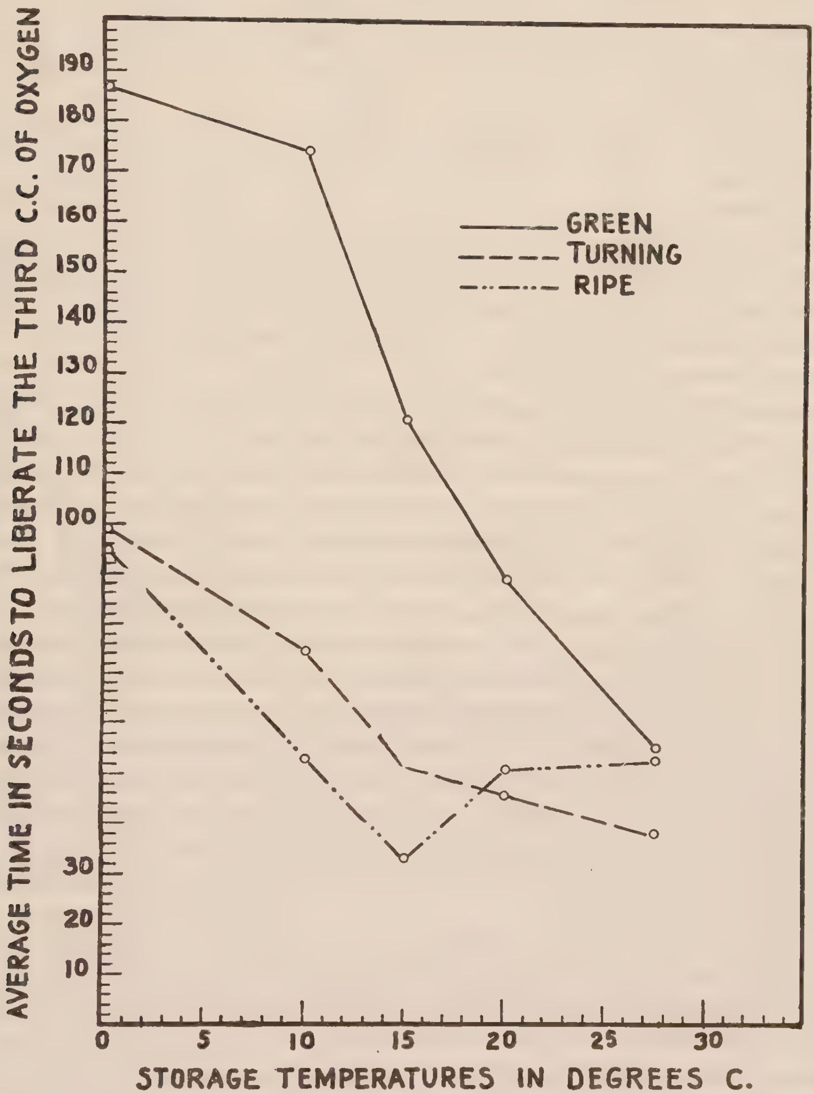


Chart 1.—Chart showing the catalase activity of green, turning and ripe fruits after the 3rd. cc. liberation.

DISCUSSION OF RESULTS

Data presented in table 1 show that at 27.5°C. ripe chico fruits remained in good condition for 2 days. After this time the fruits

became rather soft and mushy; some people would find them undesirable. At 20°C. the ripe fruits remained in a marketable condition for an average of 4.2 days, at 15°, 5.8 days, at 10°, 8.4 days, and at 0°C., 12.6 days. The results of the experiment show very clearly the beneficial effect of the low temperature. That is, to prolong the life of the ripe chico fruit, storage at 0°C. was the best of the five temperatures studied.

The green and the turning fruits did not ripen when placed continuously in either the 10° or 0°C. temperature. At 0°C. the green fruits did not ripen when placed in cold storage more than 5 days. Under 5 days storage when the fruits were removed to room temperature they ripened normally. The turning fruits ripened well if not left in the 0°C. storage longer than 6 days. If they were left in longer they did not ripen at all. They became hard and so were useless for eating purposes.

At 10°C. the green and the turning fruits stood longer, duration average for the green being 8.4 days and for the turning, 11 days. When the green fruits were moved from the 10°C. storage to room temperature before 8 days and the turning before 11 days, they ripened normally. The fruits did not ripen when kept longer in storage. They became hard so were useless for eating purposes.

In the other temperatures the fruits continued to ripen in storage. At 15°C. green fruits ripened after an average of 14.6 days and remained in good condition from 3 to 4 days. After this time the fruits were water-soaked in appearance and were no longer marketable. The turning fruits ripened after an average of 12.6 days, remaining in good condition for an average of 3.8 days. It is interesting to note that when the turning fruits were ripened under room temperature they kept longer, the average time being 5.8 days; when allowed to ripen at 15°C. the green fruits kept only 3.4 days and the turning, 3.8 days.

Just why the fruits ripened at room temperature kept longer in 15°C. than those ripened in this storage is not known. Gonzalez (1931) suggested that at low temperatures there may be an inhibition in the activity of certain enzymes which may result in a certain amount of injury to the fruit. In the case of banana (Pascual, 1930) and papaya (Enrile, 1930) the fruits did not ripen at all at low but not freezing temperatures. In the case of chico, however, ripening took place, but the ripened fruits did not keep long.

The green fruits stored at 20°C. ripened in an average of 7.4 days and remained in excellent condition for an average of 5 days, making a total storage life of 12 days. The turning fruits ripened

in an average of 5 days and remained in excellent condition for 5 days, making a total storage life of 10 days. At 27.5°C. the storage life of the green fruits was 6.6 days and of the turning, 5.4 days.

The freezing point of the sap of the ripe chico fruits (tables 2 and 3) varied from –3.09°C. (37.1 atmospheres) to –3.67°C. (44.04 atmospheres) with an average of –3.35°C. (40.33 atmospheres). Theoretically the optimum storage temperature should be approximately –2°C., but as given above, the fruit were adversely affected by low temperature.

The freezing point of the sap extracted from tissues previously frozen was very much lower than that of the sap from unfrozen tissues. The freezing point of the sap of the unfrozen tissue varied from –2.40°C. (28.82 atmospheres to –2.93°C. (35.17 atmospheres with an average of –2.71°C. (32.47 atmospheres; that of the previously frozen fruits ranged from –3.08°C. (37.08 atmospheres) to –3.46°C. (41.60 atmospheres) with an average of –3.30°C. (39.68 atmospheres). The difference is significant, having a ratio 1 to 8. This difference can be explained on the basis of increased permeability of the cell membrane as a consequence of previous freezing so that more of the solute is extracted with the sap. San Pedro (1932) in his work on the lanzon also found significant differences, that of previously frozen tissues being the lower.

The catalase activity of chico fruits (tables, 4, 5 and 6) varied according to the tissue used, stage of maturity of the fruit and storage temperature used. In table 4 it may be seen that the stem end had a much more active catalase activity than the middle portion or the stigmatic end. The average for the 1st cc. for stem end was 14.67 $\pm$ .18 seconds, for the middle portion, 20.53 $\pm$ .17 seconds and for the stigmatic end, 27.93 $\pm$ .18 seconds. The differences in the catalase activity of the different regions were significant. Averages for the 2nd cc. and 3rd cc. were likewise significant. Enrile (1930) working on the papaya obtained a significant difference between the stem end and the stigmatic point, the latter being the more active. This result is just the opposite of that found in the present work. Enrile suggested that increased catalase activity is associated with the ripeness of the fruit, thus in the papaya he obtained higher activity at the region near the apex which seems to be the part of the papaya to ripen first. In the case of the chico it is commonly observed that the stem end ripens first, hence, the results obtained in this paper are still in accord with the findings of Enrile.

Data presented in table 5 support the statement that the catalase activity of the chico is influenced by the stage of maturity of the fruit. For the green fruits the catalase activity of the 1st cc. had an average of 37.1 ± .99 seconds, for the turning, 21.5 ± .67 seconds and for the ripe, 18.5 ± .61 seconds.

The data in table 6, show no significant difference in catalase activity between the ripe and turning fruits stored at 0° and 10°C. However, the differences in catalase activity at these temperatures between the green fruits on the one hand and the turning and ripe fruits on the other were significant. The green and turning fruits increased their activity with increase in temperature. The catalase activity of the ripe fruits increased significantly up to 15°C. As the temperature became higher there was a gradual decrease in catalase activity. Between 15° and 20° the difference was not significant, but between either 15° or 20° and 27.5°C. there was a significant decrease.

The results of the experiment also show that there was a tendency of the catalase activity of the fruits to increase as they ripen. The difference in activity is significant between the green fruits and turning fruits for all temperatures; but there was no consistent difference between the turning and the ripe.

At 0°C. the catalase activity for green fruit per cubic centimeter was 57.44 ± .91 seconds; for turning fruit, 29.56 ± 2.27 seconds, and for ripe fruit, 30.67 ± .54 seconds. At 10°C. the catalase activity for green fruit was 51.33 ± .35 seconds, for turning fruit, 24.56 ± 2.68 seconds, and for ripe fruit, 23 ± .86 seconds. At 15°C. the catalase activity for green fruit was 38 ± .99 seconds, for turning fruit, 19 ± .36 seconds and for ripe fruit, 14 ± .53 seconds. At 20°C. the catalase activity for green fruit was 29 ± .73 seconds, for turning fruit, 16.1 ± .23 seconds and for ripe fruit, 15.67 ± .31 seconds. At 27.5°C. the catalase activity for green fruit was 20.56 ± .32 seconds, for turning fruit, 13.67 ± .28 seconds, and for ripe fruit, 17.44 ± .32 seconds.

SUMMARY OF CONCLUSIONS

1. Of the different temperatures used, 15°C. for the green and turning fruits was the best. The turning fruits remained in good condition for an average of 17 days and the green fruits for an average of 18 days.

2. The best temperature for the ripe chico was 0°C. At this temperature the fruits kept in good condition 12 to 13 days.

3. Green and turning fruits stored at 0°C. for not more than 5 and 6 days, respectively, ripened normally when moved to room temperature (27°–30°C.).

At 10°C. green and turning fruits had to be transferred to room temperature within 8 and 10 days, respectively, in order to ripen them normally. When they were left either at 0° or at 10°C. for over this duration the fruits did not ripen, hence, became useless for eating purposes.

4. There was a significant difference in the freezing point of the juice extracted from unfrozen and previously frozen tissues, the difference being 0.59°C. or 7.11 atmospheres (based on 5 duplicate determinations) lower for the tissues previously frozen.

5. The catalase activity increased as the fruits changed from green to turning. There was no consistent difference between the catalase activity of turning and ripe fruit.

6. The catalase activity of the stem end was more active than that of the middle and that of the middle was faster than that of the stigmatic end. Averages per cubic centimeter for stigmatic end were 27.93 ± .18 seconds and for middle portion 20.53 ± .17 and for stem end 14.67 ± .18 seconds.

7. Catalase activity became faster as the temperature increased. Averages per cubic centimeter for green fruits at 0°, 10°, 15°, 20°, and 27.5°C. were 57.45; 51.33; 38; 29; and 20.56 seconds, respectively.

8. There appears to be a close parallelism between the decrease in catalase activity of the chico at low temperature and the failure of the fruits to ripen.

LITERATURE CITED

CARRICK, D. B. 1924. Some effects of freezing on mature fruits of apple. Cornell Univ. Agric. Exper. Sta. Memoir 81: 1–54.

CHEEMA, G. S., AND S. R. GANDHI. 1925. Refrigeration as a means of preserving mangoes and other tropical fruits. Agric. Jour. India 21: Part v: ——.

DIXON, H. H. 1914. Transpiration and ascent of sap in plants. viii + 216 p. London: Macmillan and Company, Ltd.

ENRILE, F. D. Certain cold storage studies on the papaya. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. 1931. Unpublished.)

GONZALEZ, L. G. Some freezing studies of certain citrus fruits (Thesis presented for graduation with the degree of Doctor of Philosophy from Cornell University. 1927. Unpublished.)

GONZALEZ, L. G. 1931. A study of the respiration of the chico, *Achras zapota* Linn. The Philippine Agriculturist 20: 341–348. *Fig. 1.*

HARRIS, A. J., AND R. A. GORTNER. 1914. Notes on the calculation of osmotic pressure of expressed vegetables saps from the depressions of the freezing points with the table for value of P for $\triangle = 0.001°$ to $\triangle = 2.999°$. Amer. Jour. Bot. 1: 75–78.

HARVEY, R. B. 1918. Hardening process in plants and developments from frost injury. Jour. Agric. Res. 15: 83–112.

HEINICKE, A. J. 1924. Catalase activity in dormant apple twigs; its relation to the condition of the tissue, respiration, and other factors. Cornell Univ. Agric. Exper. Sta. Memoir 74: 3–5.

PASCUAL, D. D. Some studies on the storage temperature requirements of certain varieties of bananas. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. 1930. Unpublished.)

RIDGWAY, R. 1912. Color standards and color nomenclature. ii + 433 p., 53 pl. Washington, D. C. (Published by the author.)

ROXAS, M. L. 1931. Annual report of the Director of Bureau of Plant Industry. Manila: Bureau of Printing.

SAN PEDRO, A. V. Studies on the storage temperature requirements of the lanzon (*Lansium domesticum* Correa). (Thesis presented for graduation with the degree of Master of Science in Agriculture from the College of Agriculture. 1932. Unpublished.)

TABLE 1

Showing influence of temperature on the keeping quality of the chico

TEMPERATURE	GREEN FRUITS	TURNING FRUITS	RIPE FRUITS
	Average storage life of the fruit	Average storage life of the fruit	Average storage life of the fruit
	days	*days*	*days*
0°C.	5.6 ± .152	6.4 ± .202	12.6 ± .202
10°C.	8.4 ± .202	11 ± .169	8.4 ± .202
15°C.	18 ± .169	16.4 ± .202	5.8 ± .135
20°C.	12 ± .338	10.4 ± .202	4.2 ± .135
27.5°C.	6.6 ± .202	5.4 ± .202	2

TABLE 2

Depression of cell sap from frozen and unfrozen tissues

DUPLICATE SAMPLES	UNFROZEN TISSUES		FROZEN TISSUES	
	Δ	Osmotic pressure	Δ	Osmotic pressure
	°C.	*atmospheres*	*°C.*	*atmospheres*
1a	2.703	32.446	3.083	37.076
b	2.400	28.820	3.104	37.328
2a	2.448	29.396	3.447	41.444
b	2.761	33.142	3.126	37.592
3a	2.882	34.584	3.111	37.412
b	2.931	35.172	3.445	41.420
4a	2.530	30.380	3.414	41.048
b	2.760	33.130	3.427	41.207
5a	2.703	32.466	3.383	40.676
b	2.931	35.172	3.461	41.612
Average ...	2.705 ± .044	32.47 ± .47	3.30 ± .054	39.68 ± .54

TABLE 3

Freezing point of the ripe chico fruits

DATE	DUPLICATE SAMPLES	OBSERVED FREEZING POINT	CORRECTED FREEZING POINT	OSMOTIC PRESSURE
		°C.	°C.	*atmospheres*
Dec. 3, 1931	1a	–3.590	–3.428	41.216
	b	–3.215	–3.085	37.100
	2a	–3.592	–3.419	41.107
	b	–3.500	–3.346	40.232
	3a	–3.562	–3.389	40.748
	b	–3.240	–3.107	37.444
	4a	–3.512	–3.353	40.316
	b	–3.580	–3.317	39.884
	5a	–3.250	–3.117	37.884
	b	–3.230	–3.099	37.268
Jan. 10, 1932	6a	–3.680	–3.510	42.140
	b	–3.631	–3.427	41.184
	7a	–3.540	–3.383	40.656
	b	–3.590	–3.666	44.042
	8a	–3.590	–3.426	41.172
	b	–3.692	–3.420	41.100
	9a	–3.620	–3.416	41.052
	b	–3.553	–3.346	40.222
	10a	–3.535	–3.378	40.596
	b	–3.585	–3.423	41.136
Average		–3.514 ± .185	–3.352 ± .207	40.325 ± .220

TABLE 4

Catalase activity of different regions of the chico

PART OF FRUITS USED	SAMPLE NO.	TRIPLICATE DETERMINATIONS	TIME REQUIRED TO LIBERATE 1ST, 2ND AND 3RD CC. OF OXYGEN		
			1st cc.	2nd cc.	3rd cc.
			sec.	*sec.*	*sec.*
Stem end	1	a	12	21	34
		b	13	22	33
		c	12	21	35
	2	a	15	29	40
		b	16	29	41
		c	16	28	40
	3	a	17	28	42
		b	15	29	41
		c	16	29	42
	4	a	12	20	33
		b	13	22	34
		c	15	24	32
	5	a	16	26	37
		b	15	24	34
		c	17	26	38
Av. number of seconds required to liberate first cc.					14.67 ± .383
Middle portion	1	a	20	34	55
		b	20	33	56
		c	21	32	55
	2	a	20	39	59
		b	21	38	59
		c	20	38	58
	3	a	22	41	64
		b	21	40	64
		c	22	42	63
	4	a	20	35	56
		b	21	33	52
		c	20	32	54
	5	a	19	34	57
		b	21	35	55
		c	20	36	54
Av. number of seconds required to liberate first cc.					20.53 ± .168
Stigmatic end	1	a	30	57	92
		b	29	57	93
		c	29	56	92
	2	a	27	55	85
		b	28	55	87
		c	28	56	86
	3	a	27	55	85
		b	27	55	86
		c	28	28	85
	4	a	27	55	83
		b	29	56	89
		c	28	56	85
	5	a	27	55	86
		b	28	57	85
		c	27	56	87
Av. number of seconds required to liberate first cc.					27.93 ± .179

TABLE 5

Influence of maturity on the catalase activity of the chico

MATURITY OF FRUITS USED	SAMPLE NO.	DUPLICATE DETERMINATIONS	TIME REQUIRED TO LIBERATE 1ST, 2ND AND 3RD CC. OF OXYGEN		
			1st cc.	2nd cc.	3rd cc.
Green	1	a	35	55	93
		b	35	64	96
	2	a	42	71	121
		b	48	78	121
	3	a	37	69	110
		b	38	70	115
	4	a	31	59	89
		b	31	60	92
	5	a	36	65	105
		b	40	72	115
Av. number of seconds required to liberate first cc.					37.1 ± .986
Turning	1	a	23	41	63
		b	22	40	63
	2	a	23	37	68
		b	26	38	61
	3	a	25	34	65
		b	22	31	62
	4	a	19	37	59
		b	18	36	59
	5	a	17	31	52
		b	20	32	55
Av. number of seconds required to liberate first cc.					21.5 ± .672
Ripe	1	a	19	32	41
		b	19	30	42
	2	a	23	33	45
		b	24	43	51
	3	a	18	36	49
		b	17	29	40
	4	a	15	28	37
		b	15	26	38
	5	a	17	27	37
		b	18	27	45
Av. number of seconds required to liberate first cc.					18.5 ± .616

TABLE 6

Influence of storage in various temperatures on the catalase activity of the chico

STORAGE TEMPERATURES	SAMPLE NO.	TIME REQUIRED TO LIBERATE 1ST, 2ND AND 3RD CC. OF OXYGEN								
		Green fruit			Turning fruit			Ripe fruit		
		1st cc.	2nd cc.	3rd cc.	1st cc.	2nd cc.	3rd cc.	1st cc.	2nd cc.	3rd cc.
°*C*		*sec.*	*sec.*	*sec.*	*sec.*	*sec.*	*sec.*	*sec.*	*sec.*	*sec.*
	1a	52	99	188	20	40	70	30	54	92
	b	55	100	190	22	42	73	28	58	94
	c	58	102	193	22	43	75	31	57	92
	2a	62	107	196	27	55	91	35	59	105
0	b	63	109	198	26	54	89	32	56	100
	c	62	108	197	26	55	90	31	57	101
	3a	52	101	172	40	76	130	28	55	90
	b	53	103	173	42	82	136	31	60	93
	cc	53	102	170	41	80	134	30	58	93
Av. number of seconds required to liberate 1st cc.		57.44 ± .906			29.56 ± 2.267			30.67 ± .539		
	1a	50	102	170	20	37	62	20	33	51
	b	52	104	176	15	34	57	24	37	53
	c	51	104	178	18	36	59	22	36	52
	2a	49	102	177	20	37	59	25	38	60
10	b	50	103	178	20	37	56	26	36	61
	c	52	104	177	22	38	60	30	35	62
	3a	52	101	172	37	61	105	19	33	50
	b	53	103	173	34	62	106	21	32	47
	cc	53	102	175	33	63	105	20	33	48
Av. number of seconds required to liberate 1st cc.		51.33 ± .350			24.56 ± 2.684			23. ± .858		

TABLE 6 (Continued)

STORAGE TEMPERATURES	SAMPLE NO.	TIME REQUIRED TO LIBERATE 1ST, 2ND AND 3RD CC. OF OXYGEN								
		Green fruit			Turning fruit			Ripe fruit		
		1st cc.	2nd cc.	3rd cc.	1st cc.	2nd cc.	3rd cc.	1st cc.	2nd cc.	3rd cc.
15	1a	35	65	115	17	30	45	14	22	34
	b	36	64	110	20	35	46	14	21	33
	c	37	67	112	18	33	45	16	23	37
	2a	35	60	105	19	36	44	17	21	35
	b	36	63	107	20	34	45	15	20	33
	c	34	65	109	17	31	42	16	25	36
	3a	42	87	142	20	41	65	14	22	34
	b	43	90	144	20	41	67	10	19	29
	c	44	89	143	21	42	67	10	18	29
Av. number of seconds required to liberate 1st cc.		38 ± .99			19 ± .359			14 ± .528		
20	1a	25	52	90	16	24	43	17	32	53
	b	26	52	93	15	22	46	17	33	53
	c	25	51	89	17	28	47	17	33	54
	2a	30	54	92	16	25	42	14	30	48
	b	30	57	87	18	27	40	15	30	47
	c	31	58	86	14	26	39	14	30	49
	3a	33	62	92	16	25	46	15	32	52
	b	32	61	90	17	27	48	16	33	51
	c	29	58	86	16	25	45	16	33	52
Av. number of seconds required to liberate 1st cc.		29 ± .726			16.1 ± .230			15.67 ± .308		
27.5	1a	19	34	56	15	25	39	17	32	55
	b	22	36	55	14	24	38	18	35	58
	c	21	36	55	12	22	37	15	33	59
	2a	20	35	57	14	26	39	18	29	43
	b	23	36	56	15	26	40	17	28	46
	c	20	37	57	13	28	36	16	27	40
	3a	19	33	54	13	23	38	19	36	59
	b	20	37	56	12	22	39	18	35	58
	c	21	35	57	14	26	37	19	37	62
Av. number of seconds required to liberate 1st cc.		20.56 ± .315			13.67 ± .275			17.44 ± .315		

ABSTRACTS [1]

A statistical study of the relation of the breaking strength of seed cob to the yield of Philippine Native Yellow Flint corn. JOSÉ C. SADDUL. (*Thesis presented for graduation with the degree of Bachelor of Science in Agriculture, 1932, from the College of Agriculture No. 438; Experiment Station contribution No. 996.*)—The object of the work was to find whether or not there is a correlation between the yield of corn and the breaking strength of the seed cob. Two planting trials were conducted in the Experiment Station field of the College of Agriculture. The field covered an area of approximately 12,000 square meters or 1.2 hectares. One hundred and twenty ears in each trial were tested for the breaking strength of the seed cob. The seeds were planted ear-to-the-row. Three hundred kernels from each ear were used for planting materials.

The yield of each ear was determined by obtaining the average yields of the corresponding rows in the three plots. The breaking strength of the seed cobs were tested immediately after shelling.

The coefficients of correlation and their probable errors were computed. In the first trial the coefficient of correlation was –0.152 with a probable error of ±0.0589, and in the second trial with a coefficient of correlation of –0.102 and a probable error of 0.0596.

1. The result proved that there is no significant correlation between breaking strength of the seed cob and the yield of corn.

2. It would seem that the popular belief of farmers that the breaking strength of seed cob is related to the yield of corn is unfounded.

—Abstract by Melecio Duran

A comparison of the invertase and hydrochloric acid methods of inversion and also determinations of the per cent glucose in final molasses of two Philippine sugar centrals for one milling season. CORNELIO G. LEMONCITO. (*Thesis presented for graduation, 1931, with the degree of Bachelor of Science in Sugar Technology from the College of Agriculture, No. 439; Experiment Station contribution No. 997.*)—The objects of the work were three; namely, (*a*) comparison of the per cent sucrose in final molasses with the use

[1] Abstracts prepared as a part of the required theme work in English 3a, College of Agriculture.

of invertase and hydrochloric acid as reagents for inversion; (*b*) to find variations in the above methods of analyses, during one milling season; and (*c*) to obtain the glucose-sucrose ratio, in order to determine whether or not the presence of glucose caused the difference obtained regarding per cent sucrose.

The author analyzed samples of final molasses obtained weekly from two Philippine sugar centrals, the Victorias Milling Company and Bacolod-Murcia using the two methods. Separate determinations of each sample for Brix solids, polarization, sucrose and glucose were made. The sample for analysis was prepared by dissolving and thoroughly mixing 150 grams of the original molasses in a tared copper bucket in 750 grams of rain water. The Brix solids were determined by the use of a Brix hydrometer. The corrected Brix multiplied by six gave the gravity solids of the original sample. The polarization was obtained by clarifying from 600–700 cc. of the diluted solution from the Brix determinations, with 30 grams of Horne's dry lead-subacetate and filtering. Then exactly 75 cc. of the filtrate were placed in 100 cc. volumetric flask and 100 cc. of 10 per cent H_3PO_4 were added; made up to volume with water and treated with zinc dust to make the solution clear. Direct readings were obtained from a saccharimeter using a 200 mm. tube. From the readings and uncorrected Brix, the per cent polarization was obtained in the regular manner. The sucrose was analyzed using the two methods of analyses. With the use of of HCl, exactly 75 cc. of the clear filtrate from the lead sub-acetate treatment were pipetted into a 100 cc. volumetric flask, then 2 cc. of 1:1 HCl were added. The flask, provided with a thermometer, was heated to 65°C. in a water bath. Ten cc. of 1:1 HCl were again added and the inversion completed for 30 minutes. The solution was cooled in running water, made up to volume, adding zinc dust when necessary, filtered and polarized using a 200-mm. water-jacketed tube, noting the temperature of the solution at the time of polarization. The per cent sucrose was computed by the use of the formula: Sucrose = $\frac{100\ (D - I)}{142.^\circ - 0.5T} \times$ where D is the direct reading; I is the invert reading and T is the temperature in degrees Centigrade. With the use of invertase, about 200 cc. of the filtrate from the lead subacetate clarification were treated with anhydrous potassium dihydrogen phosphate, until deleading was complete, and then filtered. Then, 75 cc. of the filtrate were pipetted into a 100 cc. volumetric flask and 1 cc. of a 10 per cent H_3PO_4 solution and 5 cc. of one per cent invertase were added. The solution was heated in a water bath to 50–55°C. for

one hour with frequent shaking, then allowed to stand for two hours at room temperature. Ten cc. of a 10 per cent H_2PO_4 were added; the solution then cooled and made up to volume using zinc dust to make the solution clear. The solution was then filtered, invert readings taken in the regular manner, applying corrections for the optical activity of the invertase used. The sucrose was calculated by the formula; Sucrose $= \frac{100\ (D - I)}{F - 0.5\ T} \times$ factor, where $F = 141.17 + 0.073\ m.$; and $m =$ grams sucrose per 100 cc. The apparent and gravity purities were calculated in the regular manner. The method of Enyon and Layne was used in glucose determination.

The following results were obtained by the author:

1. There was a difference in apparent and gravity purities in the use of the two methods. The difference in gravity purity varied from 0.05 to 1.58 per cent in the samples from the Victorias Milling Company, and from 0.01 to 1.06 per cent in the samples from Bacolod-Murcia.

2. Sucrose obtained by the invertase method was generally higher than by the hydrochloric acid method. The difference varied from a minimum of 0.04 to a maximum of 0.61 per cent in the samples from Victorias Milling Company, and from 0.01 to 0.66 per cent in the samples from Bacolod-Murcia.

3. Deviations occurred in the invert readings by the HCl method.

4. The glucose content of final molasses for one milling season was inversely proportional to the sucrose content and when the glucose content was high, there was no difference between the two methods of inversion.

The following conclusions were made by the author:

1. Sucrose by the invertase method was generally higher than sucrose by the hydrochloric acid method.

2. Glucose varied inversely with sucrose content.

3. High glucose content had no effect on the two methods of inversion.

—*Abstract by D. E. Batenga*

Sesamum culture as affected by seed selection. SIMEON S. FLORES. (*Thesis presented for graduation, 1917, with the degree of Bachelor of Agriculture from the College of Agriculture No. 440; Experiment Station contribution No. 998.*)—The objects of the experiment were to select individuals of high yielding capacity, and to test and acclimatize some foreign varieties at different seasons of the year.

The varieties of sesamum used were named as to color of seed and their places of origin. They were White 1622 F_3, from Burma; White 404 F_3 and Black 403 F_3, from Japan; White 6382, from China; and Black 326 F_1, Reddish 413 F_1, White 6383, Reddish 6384 and Black 6385, local. Two sets of plantings were made, one in July and another in November. In the first set, all the varieties were used, except 6382, 6383, 6384 and 6385, which were planted only in the second set. They were planted in rows in plots four meters by 12.5 meters, each row planted to seeds from one plant. Only varieties 1622 F_3, 404 F_3 and 326 F_4 germinated. The second planting was made in November. The seeds used—except varieties 6382, 6383, 6384 and 6385 which came in later—were obtained from the first planting. Seeds from rows that gave the lowest yield were also used to find out whether they would yield more when planted in a different season.

The computed increases in yield per hectare (on the basis of 133,333 plants to a hectare) through selection in the different varieties were 195.11 kilograms for variety 6382 F_1, 329.08 kilograms for 1622 F_3, 379.00 kilograms for 6383 F_1, 401.00 kilograms for 6384 F_1, and 256.40 kilograms for 6385 F_1. No data were presented for variety 404 F_3. Selections were made before harvesting. The characters considered in selection were production, maturity of the crop, hardiness of the plants and uniformity of maturity of the capsules on the plant. The plants were harvested as soon as the lower capsules began to open.

The most destructive pest was the thrips. Plants attacked by this insect produced few capsules or none at all. Damping-off occurred when the plants were small, leaf spot when the plants were about to mature, and powdery mildew at the beginning of the dry season.

The results were summarized by the author as follows:

1. The yield of sesamum can be increased by selection in the field, by cultures from selected individuals and by careful comparison of the progeny.

2. Productivity of sesamum is in general directly correlated with branchiness and uniformity of capsules that mature.

3. The climatic conditions that prevailed from June to October favorably influenced the production of capsules.

4. The varieties 6382, 6383, 6384 and 6385 can be best grown during the dry season, and 1622 during the wet season. All these varieties except 1622 need further improvement and selection.

5. Late varieties mature sooner in the dry season.
6. Of the varieties tested for the November planting, only 1622 gave a fair harvest.
7. Light soils are favorable for the growth of sesamum.

—*Abstract by Getulio B. Viado*

KERNELS

"CORN FROM THE SHEAVES OF SCIENCE"

The life cycle of rice is too short to permit "buñga" to form flowers and capsules. But, if the rice is allowed to ratoon, small flower buds of "buñga" are produced.

The slender varieties of sugar cane are very susceptible to the smut caused by *Ustilago scitaminea* (Rabh.) Syd.

Experiments in this College show that cyanamid reduces infection of sugar cane by the root parasite, *Aeginetia indica* L. and stimulates the canes to more vigorous growth.

As a source of body fuel rice is just as good as wheat flour. Weight for weight sweet potato gives more calories than Irish potato.

During December, January and February, ten days may be considered a limit for holding hatching eggs, but in the hottest months of the year all eggs should be set while fresh.

The gestation period of the different classes of Philippine animals is as follows: Philippine cattle, 284 days; Philippine carabao, 320 days; goats, 148 days; Berkjala swine, 114 days.

The amount of feces voided by a Philippine pony averages 2311.7 kgm. yearly.

The average yearly production of fertilizers from one horse is as follows: nitrogen, 6.47 kgm.; phosphoric acid, 13.18 kgm.; potash, 2.54 kgm.; lime, 4.85 kgm.

Sheep breed mostly in May and June and again in December. The lambing time takes place heavily in May and even more heavily in October and November.

Instead of buying expensive vitamins from the drug store, eat fruits such as orange and mandarin, and vegetables such as tomato, camote leaves, malungay, kulitis or uray.

CURRENT NOTES

A local ice-cream plant in Washington D. C. using fresh mangoes that had been frozen and shipped to that country from the Philippines made 1,000 gallons of the cream in order to test the popularity of the new flavor. It is reported that the entire stock was sold out on the day the advertisements appeared announcing the new ice cream.

The Philippine Journal of Commerce, July, 1934

It has repeatedly been proved that in balanced and reorganized [agricultural] propositions the horse of the right type and in proper hands can perform work more cheaply than mechanical power. . . . In our more intensive grain-growing areas, the mule has long since displaced the ox as being cheaper and more efficient draught power.

One of the most important results of low prices for surplus grain in the more progressive countries is its conversion into "horse power." The farmer discarded mechanised purchased power for farm power, and his friend of old, the reliable horse, again came into his estate.

Farming in South Africa, July, 1934

The Better Farming Train, conducted by the Department of Agriculture and the Victorian Railways Commissioners, will shortly commence another tour. . . . The train will leave Melbourne on Monday, 17th of September. . . .

A feature of the train will be the live-stock carried. Typical dairy cattle of the Dairy Shorthorn, Jersey, Ayrshire, and Friesian breeds will be included, while Large White Tamworth, and Berkshire pigs and several prize-winning rams of various breeds will be present also for inspection. . . .

A seeds exhibit will emphasize the importance of all those factors which determine high quality in seeds. Trueness to variety of a seeds sample, the amount and nature of impurities present, germinating capacity, and such other factors as bushel weight, colour, and brightness will be stressed, and exhibits will illustrate methods of determining or estimating the occurrence of these factors. The nature, habit and value of perennial and annual pastures for

graziers and dairymen in the North-East of Victoria will be dealt with.

In the wheat-growing section modern wheat farming practices and recommendations with regard to varieties of wheat and oats, fertilizing, cultivation methods, and disease control will be graphically depicted.

New methods of re-working fruit trees by plug grafting and bark grafting will be demonstrated, while recent experiments on the nutrition and manuring of fruit trees are to be represented pictorially. Instructions on the setting out of orchards for interpollination will be made available while the symptoms, life-history, and methods of control of the various orchard pests will be explained.

Journal of Agriculture, (Victoria-Australia) September, 1934

Progress in cellulose chemistry is just beginning to strike its stride. The rayon, cellulose and film industries are only a beginning of new industries based upon cellulose as a raw material. Pulp and paper will continue to become more and more important in this next century of advanced civilization. —Bjarne Johnson, *Director research staff, Hammerhill Paper Company.*

Science-Supplement, June 1, 1934

A Brazilian product of the wilds which has joined the "Mr. Peanut" propaganda is the cashew nut. Poisonous in its raw and unshelled form, it becomes delicious after being roasted. . . . The Brazilian cashew nuts are destined to be as popular in new communities in United States as they are in eastern cities.

To make the cashew nut edible it is removed from its caustic oily shell and thoroughly roasted. The fruit makes a delicious preserve. The oil obtained from the nut is nondrying and has an iodine content of 84 per cent.

The Pan American Union, August, 1934

Research work in the Chemical Engineering Department of Iowa State College has shown that chicken feathers may dissolve in caustic soda and then be thrown out of solution in a new form by acids. This new material may be molded to any shape and hardened by formaldehyde. The finished material is said to be fairly

hard, very elastic, an excellent electrical insulator; resistant to water, heat, dilute acids and alkalies. Somewhat similar plastics are being made commercially from milk casein.

Science, August, 1934

COLLEGE AND ALUMNI NOTES

Mr. Charles A. Glunz, head of the Industrial Department of Silliman Institute, was a recent Campus visitor. He was especially interested in the different uses of fibers from different fiber producing plants.

Mr. Glunz is an old timer in the Islands. He came as a Y. M. C. A. worker with the American troops at the beginning of American administration in the Philippines.

On one evening of his visit Mr. Glunz spoke in the Center on his memories of American Occupation, his experiences when he first came to the Islands and the changes he has seen since then.

Among the foreigners who visited the College recently were Mr. S. Fujioka of Okayama, Ken, Japan, who was interested in the different medicinal plants in the Department of Agronomy stock cultures.

Mr. C. F. Cooke of the Government Experiment Station, Federated Malay States was a Campus visitor especially interested in what the College has done and is doing with coconuts. He conferred with Dr. N. B. Mendiola and Dr. Pedro David on the culture and experiments on coconut.

Mr. Pablo Lorenzo former member of House of Representatives together with Dr. K. Oshima connected with the Ohta Development Company in Davao visited the College recently and were shown around the different departments by Dean Gonzalez.

Dr. Alexander Gordon '23 of the La Carlota Sugar Central recently sent to the Department of Agronomy plants of Bengal and elephant forage grasses. These grasses will be added to the collection of forage grasses of the College and will later be studied for their feeding values.

The ninety-seventh regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Poultry Building, College of Agriculture, on Thursday, October 25, 1934 at 7:30 p. m.

The following papers were read and discussed:

"Preliminary studies on the marcottage of avocado."

By Mr. A. San Pedro

"Tolerance of mealy bugs to drying of host tissue."

By Dr. L. B. Uichanco

"The introduction of *Nepheliums* in the College of Agriculture from Java."

By Dr. N. B. Mendiola

Mr. C. Balangue '16, provincial agronomist in charge of the district comprising Cagayan and Batanes was a recent Campus visitor. He was especially interested in the work of the College on cotton.

Mr. Pedro Pereyra '27 in charge of the Lucban Agricultural Experiment Station on a recent visit to the College reported his success in making panama hats from the panama hat palms obtained from the College. While here be visited the Division of Permanent Farm Crops where he made observations on the manufacture of brushes from the cabo-negro fibers. He bought one cavan of Ramai rice for seed purposes and requested a few cuttings of cassava in exchange for cuttings of black pepper and planting materials of tea.

Mr. Victor T. Feliciano '25, a farmer in Concepcion, Tarlac, recently conferred with Dr. N. B. Mendiola about cassava culture and left an order for 50 meters of cassava cuttings of each of varieties Kapo White and Mandioca Sao Pedro Preto.

In response to the petition of many students who want to have a working knowledge about the culture and manufacture of cotton a course on this crop is now being offered. The course covers the study of the different methods involved in the production of the crop; of the different groups, species, types and varieties of cotton; of seed and varietal selection; of ginning, classing and grading; of pests and diseases; of marketing, spinning, and to a certain extent the manufacture of the cotton fabrics. This last phase will include visits to cotton mills.

The Secretary of the College of Agriculture reports the following students as graduating in October.

For the degree of Bachelor of Agriculture

1. Allas, Macario M.
2. Asuncion, Alvaro F.
3. Bumagat, Guillermo
4. Felix, Alberto C.
5. Lopez, Francisco B.
6. Olivar, Ruperto
7. Padilla, Pablo S.
8. Piamonte, Arcadio P.

For the degree of Bachelor of Science in Agriculture

1. Arana, Raul Ruiz
2. Arancillo, Vicente B.
3. Bulanadi, Julian M.
4. Briones, Felix B.
5. Calimbas, Francisco L.
6. Corales, Macario P.
7. Dolores, Emeterio P.
8. Estocapio, Simeon A.
9. Felipe, Restituto
10. Madrid, Victoriano J.
11. Meneses, Leoncio
12. Ramos, Alberto S.
13. Ramos, Exequiel B.
14. Rivera, Teofilo B.
15. Santos, Alberto D.
16. Smitananda, Phanom
17. Tolentino, Cesar S.
18. Yadao, Pedro S.
19. Yñiguez, Bonifacio T.

For the Certificate in Agricultural Education

Bulanadi, Julian (B.S.A.)

GLIMPSES OF COTABATO PROVINCE [1]

FROM THE NOTEBOOK OF A SOIL TECHNOLOGIST

Accompanying Dr. Edwin Bingham Copeland, one of our three pioneers in scientific agriculture who are still active in the Philippines, the writer made in August and September, 1933, a short trip to Cotabato Province, Mindanao.[2] En route to and from Cotabato, stops were made at various ports, permitting more or less hurried trips inland. While these trips were for the study of the soil conditions and the collection of samples, some of the observations which were of a less technical nature will be recorded in a subsequent paper.

COTABATO

A pioneer town, Cotabato, treeless and bare, on the lowlands along the muddy Cotabato River,[3] just inside of the nipa and mangrove swamps, with most of its buildings, including the church, of galvanized iron, is very unattractive. The one redeeming feature is the low hill, with steep slopes, to the south of the town, on which the provincial capitol buildings are situated. It is this hill, where the Moro "fort of stone," or *cota bato*, was located which gives its name to the town, and to the province.

This hill, like those at Reina Regente, Pikit, and other places in and around the Cotabato Valley, is of coral rock, and is a relic of the time when the island of Mindanao was not so high above the sea as at present—in fact, of the time when Mindanao was not one island but five, with shallow seas between. Geologically Recent, the central part of the Cotabato Valley is still very low, with a vast expanse of timbered and open swamps, particularly in the rainy season. Travelling by boat on the Rio Grande de Mindanao, one is impressed by the lowness of the land. The river banks are often

[1] General contribution from the College of Agriculture No. 462. Received for publication November 7, 1934.

[2] Thanks are due particularly to Doctor Copeland for making this trip possible and profitable. Thanks are also due to the Bureau of Plant Industry for the payment of travelling expenses, and to that Bureau and the Bureau of Forestry for placing facilities and field staff at our disposal.

[3] The Cotabato River and the Tamentaka River are the two main distributaries of the Rio Grande de Mindanao. This river, rising far in the interior of Bukidnon Province, is variously known as the Mindanao River, Rio Grande, Pulangui River, etc.

only a meter or two above the river level, so that for the irrigation of rice in the fields back of the river, the Moros often dig a small ditch through the natural levee, permitting the outflow of river water. When the river is low, these same ditches are also useful for dewatering the rice fields. These canals also serve as highways for the *bancas* (dugout canoes) which are almost the only medium of travel for the Moros in the lowlands. During the 1928 earthquake, in some places the river banks settled several meters, flooding the land, and killing the coconut and other trees.

Here and there, along the banks of the river, in groves of coconut and betel palms, are the Moro villages, with their mosques. Great is the contrast between these "tin roofed" timber and bamboo places of worship and those impressive and often beautiful masonry mosques of Mohammedan India.

Usually the family bathing and washing ghats along the river are carefully enclosed with palings to prevent alligators from eating the bathers. That this precaution is necessary is too often proved. Just a few days before we passed Peidu Pulangui, a schoolboy had gone to the river bank to get some water for the school. The bank was unprotected, and the boy was eaten by an alligator. Striking evidence of the large number of alligators in the rivers and swamps of Cotabato is the thriving business of exporting the skins. The hunters are supplied with coarse salt. The skins are obtained, at once rolled in the salt, and brought to the exporter. After sorting, the green skins are packed in salt in bundles, wrapped in jute, and shipped to New York. The hunters were being paid 30 centavos per linear foot for the skins, while the exporters were selling the skins for 30 centavos per square foot. To make the good profit that results, it is easy to see that most of the skins must be of large size, much more than a foot wide. One exporter at Dulawan was at the time of our visit handling about 3,000 skins a month.

While Magindanao is a country which has been known for a long time, and was for long the home of fierce pirates, who grew lowland rice, coconuts, areca nuts, betel, etc. for their own use, it has not been thought of as an agricultural country. It is nevertheless true that at least the higher and better drained portions of the Cotabato Valley, as near Pikit and between Cotabato and Sarangani Bay, had in the past supported a large indigenous Moro population. About three decades ago Doctor Copeland travelled through these regions for the first time, and there were then abundant signs that not long before there had existed a very much larger population and much greater agricultural use of the land than have since been the

case. The expanses of *cogonals* (artificial savannas) and the relatively small proportion of commercial forests still point to this same condition.[4] The history of the region relates how, three and four decades ago, there were most terrible wars and slaughters in Magindanao resulting, at least in the case of Talic, in the practical annihilation of the inhabitants of the region.

It is but recently that the immigration of Visayan and other "Christian" Filipinos commenced; a new cycle of agricultural pioneering is everywhere apparent along the new roads that lead back from the rivers. Jungle is being cleared, some land drained and crops planted. Here and there in the clearings and along the roads are the houses, often pitifully crude, standing usually alone and unshaded by trees. Maize, which at times is reputed to give three crops a year from the same field, is one of the most popular crops; upland rice, too, does well on these new soils. While lowland rice would probably give better returns from a limited area, the making of dikes, levelling of fields, planting and *water control* require more labor.

In these pioneering regions, where new settlers are moving in and taking up lands, it is evident that at least in one important respect the homestead law is unsatisfactory: The legal maximum area of a homestead is 24 hectares, and this is the size usually applied for and granted. For good, fertile agricultural soil this is entirely too much land for one family to successfully cultivate continuously. It should be added that the cultivation of perhaps only a third of a farm to annual crops, while the remainder of the land again grows up to jungle, only in turn to be cleared and planted, constitutes a long term rotation in which the spontaneous forest growth takes the place of the green manure crop and cover crops. Such a system allows but about one-third the intensity of population that the usual types of rotation do, in which the cover or green manure crop occupies the land for considerably less than a year in the rotation.

---

[4] The Bureau of Forestry has explored much of Cotabato Province. Their estimates of the areas of forest and other cover or use of the land in the explored portions are shown in the following table: (Supplied by Forester Buenaventura, Zamboanga office, Bureau of Forestry.)

	Area explored	
	Hectares	*Percentage*
Commercial forest	1,378,593	55
Non-commercial forest	623,638	25
Open (cogonals)	344,547	14
Cultivated	54,681	2
Swamp, fresh water	84,865	3
Swamp, salt water	5,204	0.2
	2,491,580	99.2

Moreover, where land is taxed to support a government, cultivated and temporarily abandoned land both have to bear taxes. This increases seriously the effective tax burden on the cultivated land to such an extent that it is practically imperative to speed up the rotation, eliminating the period of natural regeneration of fertility.

One of two conditions results: the homesteader and his family cultivate as much of the land as they can, and they usually do it badly, leaving the rest in forest, or if cleared the land soon grows up to jungle again; or else the homesteader soon becomes a landlord with a number of tenant farmers under him. Since owner-farming is the much more desirable state for a contented prosperous people, and new regions should be colonized with farmers of this type, competent students of the question agree that the maximum size of the homestead which may be granted should be reduced to not more than 8 or 12 hectares.

In general in the settlement of the pioneer regions of the Philippines, there are *other* questions in the administration of the land laws which are the subject of very general criticism. The facts are at times difficult to ascertain, but there is no question but that in very many instances the natives, or the hardy pioneer homesteaders who have taken the land of the natives, or those who believe they are complying with the homestead law, as well as the squatters, are allowed to clear and plant the land only to have in turn their rights and titles taken from them by wealthy or influential persons. In Moro land there is a variation, in that the datu or sultan, whose house claims by heredity or conquest the suzerainty over wide tracts, will assert his rights and title to the land, at least to the extent of exacting tribute from the "Christian" intruders.

Datu Piang, unique in the history of the last 35 years in Cotabato, had died just before we reached the province. It was our privilege to be present at his home in Dulawan during the ceremonies on the seventh day after his death. We needed no guide to show us the house, for it is the only large establishment, and the house, as is the Mohammedan mourning custom, was decorated with broad strips of white muslin. One would not have guessed that the somber, silver-gray, weather-beaten house was built entirely of narra and molave.

The small town, with one row of shops facing the Rio Grande, was crowded with thousands of guests. That day there were said to be over 2,000 panditas present, who, in addition to being fed like all the thousands of others, were all given presents of money from the Datu's family. From long distances these mourners had come,

there were present even small groups of Manobos and other mountain folk. All these thousands were fed. In preparation, many temporary kitchens had been erected along the river bank. Crowds filled the compound which was roofed for the occasion with large awnings gaily decorated with appliqued designs in color. Upstairs, in the Datu's special alcove, was his seat of honor, with pillows, weapons, and betel boxes and other brass in quantity. This display was thickly surrounded by priests. Below, in the ground floor, was a chorus which continuously chanted what to us seemed strange songs.

After some time spent in the house, during which the taking of group photographs seemed to be an important feature of the celebration, we were shown outside into the courtyard. The *shamiana* or awning, while most decorative overhead, combined with the very curious and to us interesting crowds of Moros all about us, to completely cut off the breeze, making it oppressively hot. But even these distractions did not prevent the enjoyment of a most bountiful and unusual meal, served in Occidental style.

PARANG

For much of the distance to Parang, over the low hills which occupy most of the country between the high mountains on the Lanao border and the Rio Grande, runs the inter-provincial highway from Cotabato toward the northwestern boundary of the province. These low hills were submarine deposits washed out by the former rivers from the high mountains to the north, at the time when along most of the shores of the "Cotabato Sea" coral reefs were forming. The soil on these hills is of only moderate fertility, and is not well cultivated. Farther to the north, near Parang, commence the more fertile though stony soils on the basalt. In this locality, and on to Bugasan and beyond, are many coconut plantations, as well as numerous small clearings with annual upland crops.

The new pier in Polloc Bay will likely make Parang town an important port for the province, as the bar at the mouth of the Cotabato River prevents the entrance of the larger inter-island vessels. The highway north of Parang climbs high over the coastal hills, and affords magnificent views of beautiful Polloc Bay.

UPI

South beyond the Tamontaka River, and southwest of Cotabato town the road to Upi goes up over the rugged hills which were once coral reefs. The country is rough, the road steep and narrow,

though being improved. Much of the land is open cogonal, with the thin black soil seldom cultivated. The underlying limestone allows much of the rainfall to drain away, so that in general it is a dry country, and as one observer put it: "The rain sizzles when it hits the land." Farther southwest, where the route is over the soils from sedimentary rocks, there is some forest, and somewhat more agricultural activity.

The Upi Valley, a few kilometers across, with an elevation of perhaps 500 meters (1,600 ft.), and facing the coast, has a cool, moist climate. Here lowland rice growing is important, and the region promises to be a source of vegetables for the Cotabato lowlands, about 35 kilometers distant. The Upi Agricultural High School, under the capable supervision of Mr. Washington A. V. Wiren, is making distinct progress. While the school was intended for the education of the Tiruray, a tribe of timid hill folk in the region, a very considerable proportion of the students are from the homes of the Visayan and Ilocano settlers in the Cotabato lowlands, and from elsewhere in the southern islands. This is confirmed by a statement in the 1934 issue of *The Upiana*, an excellent school annual, that during the school year 1933-34 there were 49 Visayan students including 2 girls, 48 Ilocanos including 5 girls, 16 Moros including 1 girl, 13 Tirurays including 2 girls, 7 Manobos, 5 Bilaans, 4 Tagalogs including 1 girl, 2 Chavacanos including 1 girl, 1 Subano and 1 Tagabili who enrolled in the secondary classes.

KABAKAN

Going up the Rio Grande by boat beyond Dulawan, the main road east commences at Peidu Pulangui, and continuing through Pikit reaches the eastern edge of the plain at Kabakan, at the confluence of the Rio Grande and Kabakan rivers. At Pikit the old Spanish fort occupies a commanding position on the summit of the southernmost of a considerable number of limestone hills, which are also remains of the coral reefs of a former age.

For practically the whole distance the highway crosses the very flat plain, a region which is almost a swamp. East of Pikit the road runs between the river and the Liguasan swamp which practically skirts the road on the south. The banks of the Rio Grande are not high, and overflows are frequent across the road to the forest swamp.

When the interprovincial highway system of Mindanao is completed, Kabakan will be the junction of the Cotabato, Bukidnon and Davao routes. Kabakan is now a postal and market center for the

Christian Filipinos, mostly Ilocanos and Visayans, in a region which until lately was a "no man's land" between the domain of the Moros along the larger rivers and lakes in the Cotabato lowlands, and the land of the Bogobos and Manobos in the higher mountains of the Apo range. While this lower foothill region has usually been considered a "tension line" between these racial groups, it may be that the zone has been kept depopulated by malaria, for it has the necessary characteristics—low elevation, fairly rapidly flowing streams —for the breeding places of the malarial mosquitoes.

At Kabakan is located one of the older rubber plantations of the Philippines. Planted with unselected seed, and established according to the older, non-scientific methods, the project is now far from profitable—scientific agriculture of other tropical countries in too many ways is leaving the Philippines far behind.

KIDAPAWAN

Southeast from Kabakan about 40 kilometers by a poor "cart road," on the trail to Digos and Davao, is Kidapawan. This small village, at about 400 meters (1,200 ft.) elevation on the western slope of Mount Apo, has a farm school for the Manobos. After travelling the first 8 kilometers by motor truck, we hiked.

The route led through the forest, with one or two groups of clearings where Ilocanos and Visayans are growing excellent crops of upland rice, with some legumes and sweet potatoes. These settlers at Poatun are courageously invading the zone where neither Moro nor Manobo cares to live. While the forests here are fairly good, they are considered non-commercial, and it is probable that the soils as a whole are not particularly fertile. About half way to Kidapawan we came upon the first Manobo clearings, where vegetables and other upland crops were growing. The huts are wretchedly poor. Occasional small cogonals in the forest marked the site of former clearings for agriculture, and gave an opportunity to see the forest profile. We met a few outbound carabao carts loaded with abacá fiber, Filipino carters working for the Chinese merchants.

Near Kidapawan more prosperous Manobos and better huts were frequent. The settlements here and at Guinatilan and elsewhere, with the neat houses, roofed with boho (*Schizostachium*) shingles laid in decorative designs, with areca palms planted in rows along the paths and cart roads, the latter often cleared of grass and

weeds, gave an air to the villages rarely found in the Philippines. Tree houses, while seen, did not seem to be common, and apparently are used but seldom.

It was Child Health Day when we were in Kidapawan and Muaan. The Manobos in considerable numbers were attending the programs in the schools. Of course the parents were attired in their best garments. Both men and women wore short-sleeved jackets, the women wearing in addition short, stiff skirts of abacá cloth, and the men very tight, bead-decorated shorts. The most striking fabrics are of intricately woven and dyed abacá fiber, "ironed" to a polish by rubbing with a rounded stick of hard wood against a flat board. Beads are used in great quantity on the garments, while rattan and nito (a fern stem) are used for bracelets and "calflets," the latter being worn just below the knee.

The Manobos are taking a surprising interest in education for their children. On the Digos trail, east of Kidapawan Indangan, we passed a new school which had been built by the Manobos of the locality, this being the condition upon which they were to be given a teacher by the Bureau of Education. But this was only one of three new schools built by the Manobos in the Kidapawan region, on the promise that teachers would be supplied. In the Child Health program at the Muaan school it was most interesting to note the attention with which the parents and other visitors listened to the program in English, which was translated into the vernacular.

In agriculture, the Kidapawan region seems to have great possibilities which are as yet latent. The elevation, the abundant water, the good drainage, and a good soil is a combination not often excelled. The soil has to an accentuated degree a characteristic more or less common to a great many soils on tropical mountains; namely, a granulation which permits of the cultivation of a clay loam as if it were a loam or a sandy loam of temperate regions. This Kidapawan soil may be plowed and harrowed within a day after a very heavy rain. The slope of the land, however, is such that careful contour cultivation will be necessary to prevent destructive erosion under intensive cultivation.

Abacá, which grows practically wild, is at present the only money crop, for the others produced in quantity would not bear the two-day, 40 kilometer haul over the trail to Kabakan. Upland rice seems to be grown in considerable variety: we saw one caiñgin of hardly half a hectare in which were 8 distinctly different sorts of rice. Lowland rice has thus far been a failure, doubtless because

a variety suited to the cooler, elevated situation, was not used. Coffee of several sorts, grows well, and many sorts of fruit should also do well. The eagerness of the people for fish, and its scarcity suggests the desirability of greatly extending pisciculture. While an occasional datu raises fish, it is not like in Java, where a very large proportion of the farm homes, even up on the mountain slopes, have their fish ponds for home supply, and where fish are so often raised in the lowland rice fields.

ROBERT L. PENDLETON
Of the Department of Soils

The Jesuit missionaries brought from Asia to Europe plants, spices and medicines such as Peruvian bark, rhubarb and vanilla; the camellia gets its name from the Jesuit, Kamel, who sent a specimen of this flower from the Philippines to the great botanist Linnaeus.
The Power and Secrets of the Jesuits. BY RENÉ FULLOP-MILLER

The camellia, *Camellia japonica* was introduced into the Philippines from China or Japan, more probably from China. For some reason, climate, soil or want of appeal of flower to Filipinos the camellia is not common or given any particular attention in the Philippines at present. *Editor.*

Civilization has advanced only whenever and wherever the critical faculty in the people at large has been free, alive and unpolluted. It slumps whenever this is intimidated or suppressed. That is the most certain lesson of history. HERBERT HOOVER

Agriculture needs not less science in its production but more science in its economic life. It is possible to have a full science, embracing the distribution as well as the production of wealth.

HENRY A. WALLACE
Science August, 1934

Too many cranks in the world—not enough self-starters.
Penn State Farmer

SEASONAL YIELD AND PRODUCTIVE LIFE OF GUINEA GRASS (PANICUM MAXIMUM JACQ.) FOR SOILING PURPOSES [1]

VALENTE VILLEGAS
Of the Department of Animal Husbandry

In the course of providing the animals of the Department of Animal Husbandry of the University of the Philippines with cut green forage, technically known as soilage, an opportunity was presented to determine the normal life and production of fields of Guinea grass. The importance of this work lies in the fact that yield data were obtained when the grass was most suitable for feeding purposes; also, the areas used were of a size satisfactory for producing soilage to supply a reasonable number of animals.

Specifically, the objects of this investigation were: (*a*) to determine the production of Guinea grass soilage throughout the different seasons of the year; and (*b*) to find the productive life of Guinea grass fields.

The work was conducted at the College of Agriculture from December, 1925 to May, 1932 covering a period of six and a half years.

CULTURE AREAS

Two adjacent areas designated as fields A and B were used in this study. Field A had an area of 5,143 square meters and field B, 4,954 square meters. The area in each case is approximately one-half hectare. The soil in both areas is of good, friable loam but very shallow in field A and fairly deep in field B. From the appearance and growth of the plants in each field the fertility of the soil was fair.

PLANTING AND CULTIVATION

The land was tilled well with the plow and harrow so that at planting time it was free from weeds. The furrows were set at 90 cm. apart in field A and one meter apart in field B. Rootstocks of Guinea grass containing three or four shoots each were planted at 75 cm. apart in the furrows of field A and at one meter apart in field B. Field A was planted on December 14, 1925 and field

[1] Experiment Station contribution No. 1003. Received for publication August 23, 1934.

B on November 29, 1928. Whenever weeds were becoming a menace to the plants the fields were cultivated. Frequent cultivation was required during the rainy season when the weeds were abundant. Of all the undesirable plants that are harmful to Guinea grass, cogon was the most difficult to control, especially in the later life of the grass when the hills were becoming old and showing poor growth. Sensitive plants, *Mimosa pudica* Linn., casadores, *Synedrella nodiflora* (Linn.) Gaertn. and carabao grass, *Paspalum conjugatum* Berg. easily gained foothold between the rows of Guinea grass but were readily eradicated by cultivation.

HARVESTING

The Guinea grass was cut regularly to supply the animals of the Department of Animal Husbandry with soilage. During the season of excessive production the grass was cut, even if not used, to prevent the plants becoming too fibrous and unpalatable. As a rule, the plants were harvested when the flowers were beginning to show. During the hot dry season when plant growth was slow the grass was cut when suitable for feeding even when no flowers were in evidence.

In harvesting, the plants were cut close to the ground. The grass was bundled together and removed from the field as soon as possible to prevent undue drying before weighing. A Renfrew scale was used in recording the weights of the material at harvest time.

In both fields harvesting was begun one month after planting.

DISCUSSION OF RESULTS

Production

Field A. As may be seen in table 1, the field yielded heavily for only two years. The cropping of the third year ended in October, 1928, when the plants were so weak and the yield was so low that it became advisable to renew the planting. The heaviest crop was gathered the first year (1926), amounting to 13,513.8 kgm. which is equivalent to 26,216.9 kgm. per hectare. The yield was so poor that none was cut in February, April or May this year (1926), but in the six months from June,[2] when heavy rains usually start, to November, which may be considered the end of the rainy season, the total yield was 11,448.1 kgm., equivalent to 22,209.4 kgm. per hectare. Comparing this production with that for the year, it repre-

[2] ESTIOKO, ROMAN P. 1925. Weather observations at Los Baños, 1916-1923. The Philippine Agriculturist 13: 407–408.

sents 84.7 per cent of the annual crop. During the second year (1927) harvests were made throughout the year, the poorest crop, 51 kgm. (98.9 kgm. per hectare) being in May, and the heaviest yield in June, amounting to 2,776.6 kgm. (5,385.4 kgm. per hectare). From June to November the total harvest was 7,491.2 kgm. (14,479.4 kgm. per hectare). This amount represents 77.1 per cent of the harvest for this year, amounting to 9,682.1 kgm. (18,783.3 kgm. per hectare). Comparing the total harvest for this year (1927) with that of 1926, the latter is the greater by 3,831.7 kgm. (7,433.6 kgm. per hectare). In the third year (1928) no harvest was made in August. By October the plants looked so weak and so poor that the field was plowed under and replanted with new stock. The total production this year amounted to 6,469.1 kgm. (12,550.00 kgm. per hectare). The lowest yield, which was 15.9 kgm. (30.8 kgm. per hectare), was in April, and the heaviest, amounting to 1,950.0 kgm. (3,783.0 kgm. per hectare), was in May.

Adding the yields for the whole period of productive life the total amount of forage obtained in field A was 29,665.0 kgm., which is equivalent to 57,550.2 kgm. per hectare. On the basis of one year, the average yield was 898.9 kgm. (17,438.7 kgm. per hectare).

Field B. It will be noted in table 2 that during the first year (1929) the production in field B amounted to 21,655.5 kgm. (43,700.8 kgm. per hectare). Harvests were made throughout the year. The smallest crop, amounting to 213.6 kgm. (431.0 kgm. per hectare), was obtained in January, about one month after planting; the heaviest harvest, 4,275.8 kgm. (8,628.6 kgm. per hectare), was in July. From June to November the total yield was 13,946.8 kgm. (28,144.6 kgm. per hectare), representing 64.4 per cent of the year's production. The following year, 1930, the annual yield was 9,659.0 kgm. (19,491.9 kgm. per hectare) which is 11,996.5 kgm. (24,208.9 kgm. per hectare) less than the production for the first year. No harvest was made in March. The heaviest yield, amounting to 2,637.6 kgm. (5,322.7 kgm. per hectare), was in June. The production from June to November this year amounted to 5,967.0 kgm. (13,351.3 kgm. per hectare) or 68.5 per cent of the year's production. In the third year (1931) the annual production was 10,676.3 kgm. (21,544.7 kgm. per hectare) which was 1,017.3 kgm. more than the production in the second year, but 979.2 kgm. less than that of the first year. The grass was harvested throughout the year ranging from 190.1 kgm. (383.6 kgm. per hectare) in February to 2,174.0 kgm. (4,387.1 kgm. per hectare) in August. An

amount equal to 8,362.3 kgm. (16,875 kgm. per hectare) was harvested from June to November, which is 78.3 per cent of the total harvest for the year. In the fourth year (1932) appreciable harvests were made up to April, then the field was plowed as the stand of Guinea grass was very poor. No crop was obtained in February. The harvest for part of the year (1932) was 123.1 kgm. (248.4 kgm. per hectare). The total amount of Guinea grass harvested throughout the productive periods in field B amounted to 42,113.9 kgm. (84,985.8 kgm. per hectare). Computing this on one year basis, the average yearly production was 12,633.6 kgm. (25,494.6 kgm. per hectare).

Jacobson (1914)[3] states that as much as 21,543 kgm. of Guinea grass has been harvested from an area of three-tenths of a hectare from January 1 to July 1, inclusive, in 1908, at the Singalong Experiment Station of the Bureau of Agriculture. One plot having an area of one-fourth of a hectare produced 41 metric tons per hectare in 61 days. The plants in this culture were planted in the month of April. Jacobson further asserts that a yearly production of 120 tons a hectare was commonly obtained on large areas.

Galang and Paulino (1925)[4] reported a production of 1,423.45 kgm. in one year from 144 square meters of non-irrigated land and 1,192.40 kgm. from 315 square meters of irrigated land. Computing these yields on the basis of one hectare, the production from the non-irrigated land amounted to about 98.8 tons and from the irrigated area, 35.7 tons.

Productive life

From the date of planting to the time when the yields were very low, the period covered was two years and 10–1/2 months in field A. In field B, the period of production was three years and five months. Therefore, the average length of the productive life of the two Guinea grass cultures was approximately three years and two months.

SUMMARY AND CONCLUSION

1. Production records of two fields of Guinea grass are presented. The soil in field A is shallow and the plants were set 75 to 90 cm. apart. In field B the soil is deep and the plants were set at one meter each way.

---

[3] JACOBSON, H. O. 1914. Guinea grass. Bureau of Agriculture Circular No. 29. The Philippine Agric. Rev. 7: 211–215.

[4] GALANG, F. G., AND P. L. PAULINO. 1925. A progress report on forage crop investigations at the Lamao Experiment Station, Lamao, Bataan. The Philippine Agric. Rev. 18: 3–31.

2. The average annual production of Guinea grass in field A was 898.9 kgm. (17,438.7 kgm. per hectare).

3. In field B, the average yearly production was 12,633.6 kgm. (25,494.6 kgm. per hectare).

4. During the six wet months of the year, from June to November, the amount harvested was 80.9 per cent of the total annual production in field A.

5. In field B, the production during the wet season was 70.4 per cent of the year's harvest.

6. The total amount of forage obtained from field A during the period of productive life of the grass was 29,665.0 kgm. (57,550.2 kgm. per hectare).

7. The amount of forage harvested from field B during the productive period was 42,113.9 kgm. (84,985.8 kgm. per hectare).

8. The period of life of Guinea grass culture during which normal yields were obtained was two years and 10–1/2 months in field A, and three years and five months in field B. The average length of life of the two cultures was approximately three years and two months.

9. During the dry season, Guinea grass can not be relied upon to produce a sufficient amount of soilage for animals. The low yields and absence of harvests during certain months is evidence in support of this statement.

10. There appears to be a tendency for the productivity of the fields to decrease as the plants become older.

TABLE 1

Showing monthly and yearly production of Guinea grass in field A

MONTH	1926		1927		1928	
	Actual	Per Ha.	Actual	Per Ha.	Actual	Per Ha.
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
January	565.3	1,096.7	848.2	1,645.5	995.3	1,930.9
February ...	—	—	297.0	576.2	337.8	665.3
March	820.4	1,591.6	244.0	473.4	349.0	677.1
April	—	—	750.7	1,456.4	15.9	30.8
May	—	—	51.0	989.0	1,950.0	3,783.0
June	2,563.6	4,973.4	2,776.0	5,385.4	1,043.1	2,023.6
July	1,246.2	2,417.6	1,433.0	2,780.0	781.1	1,515.3
August	2,981.2	5,783.5	633.1	1,228.2	—	—
September ..	2,700.6	5,239.2	1,330.5	2,581.2	951.5	1,845.9
October	713.9	1,385.0	542.0	1,051.5	45.4	88.1
November ...	1,242.6	2,410.7	749.0	1,453.1		
December ...	680.0	1,319.2	27.6	53.5		
Total	13,513.8	26,216.9	9,682.1	18,783.3	6,469.1	12,550.0

TABLE 2

Showing monthly and yearly production of Guinea grass in field B

MONTH	1929		1930		1931		1932	
	Actual	Per Ha.	Actual	Per Ha.	Actual	Per Ha.	Actual	Per Ha.
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
January	213.6	431.0	87.5	176.6	541.8	1,093.4	73.5	148.3
February	791.9	1,598.1	867.6	1,750.8	190.1	383.6	—	—
March	2,797.6	5,645.6	—	—	262.2	529.1	7.0	14.1
April	1,618.3	3,265.7	161.5	325.9	286.3	577.8	42.6	86.0
May	2,287.3	4,615.8	1,926.3	3,887.3	512.9	1,035.0		
June	3,978.2	8,028.0	2,637.6	5,322.7	1,183.9	2,389.1		
July	4,275.8	8,628.6	895.4	1,806.9	1,624.7	3,278.6		
August	2,374.0	4,790.7	928.1	1,872.9	2,174.0	4,387.1		
September	700.8	1,414.2	442.3	892.6	1,313.6	2,650.8		
October	1,166.1	2,353.2	523.9	1,057.2	1,190.2	2,401.8		
November	991.1	2,000.0	539.7	1,089.1	875.9	1,767.6		
December	460.8	929.9	649.1	1,309.9	520.7	1,050.8		
Total	21,655.5	43,700.8	9,569.0	19,491.9	10,676.3	21,544.7	123.1	248.4

STUDIES ON SURRA: I. THE OUTBREAK OF SURRA IN 1933 IN THE COLLEGE OF AGRICULTURE[1]

MIGUEL MANRESA
Of the Department of Animal Husbandry

The inception of the studies herein reported was in the outbreak of surra in 1933 among the animals belonging to the College of Agriculture. Unfortunately, the most valuable animals were the first to become infected. Instead of wailing over the misfortune, the modes of attack of the disease were fortified, and plans were made for investigational work. The results of these investigations will be published in a series, the present paper constituting the first of the series.

HISTORY

Even in the best managed herds deaths of animals occur from various causes. In our Department of Animal Husbandry, the average percentage of mortality of adult oxen during the past five years had varied from two to five per cent, and from September, 1931, to September, 1933, no mature ox had died. But, from September 21, 1933 to November 29, 1933, a period of about three months, six mature oxen died with short intervals between. At that rate the annual mortality would be over twenty per cent. A list of the large animals belonging to the Department of Animal Husbandry that died or had aborted during that period is given below:

Table showing the oxen and water buffaloes that died or had aborted during the period from September 21, 1933 to November 29, 1933[2]

DATE	KIND	NAME OF ANIMAL	ABORTED OR DIED AND POST-MORTEM FINDINGS ON THOSE THAT DIED
1933			
Sept. 21	Ox	Don Miguel ..	Extensive and severe hemorrhages of the visceral organs.
Oct. 12	Water buffalo	Lady Una ...	Found prostrate in pasture, moving only legs. Unable to bend neck. Post-mortem examination revealed the presence of fibrinous adhesions in abdomen and pleura.

[1] Experiment Station contribution No. 1004.
Received for publication December 7, 1934.
[2] From the Log Book of the Department of Animal Husbandry.

DATE	KIND	NAME OF ANIMAL	ABORTED OR DIED AND POST-MORTEM FINDINGS ON THOSE THAT DIED
1933 Oct. 16	Water buffalo	College Boy ..	Hemorrhagic peritonitis and pleuritis with extensive fibrinous adhesions in the peritoneum and pleura.
Oct. 18	Ox	Independence .	Died suddenly in pasture. Post-mortem examination did not reveal any specific pathological lesions to which death of animal could be attributed.
Oct. 20	Water buffalo	Indian Beauty	Aborted.
Oct. 22	Ox	Corazon	Hemorrhagic gastro-enteritis with involvement of the kidneys and the urinary bladder.
Nov. 23	Ox	Madras	Died suddenly. Severe hemorrhages in the peritoneum and petichea in the visceral organs.
Nov. 23	Ox	Dolly	Septic metritis with hemorrhagic involvement of the visceral organs.
Nov. 25	Ox	Mabel	Aborted.
Nov. 29	Ox	Adam	Fibrinous adhesions in the abdominal cavity with a large abscess involving the pancreas.

In the years 1930 and 1931 when the average number of oxen of all breeds in the Department of Animal Husbandry in any month was not less than 109 but not more than 122, the number of animals that died were four adults and seven calves a year. With about the same number (120) of oxen in 1933, the deaths rose to twenty-five, of which 7 were calves and 18 were mature or nearly mature oxen. This unusually high mortality caused alarm. On October 18, 1933 while he was studying the data connected with the death of the cow named Independence, Herd No. 58, which died on that day, Doctor Gonzalez stated that the occurrence of deaths among animals in the Department so close together was unnatural and indicated the existence of an unknown cause which must be determined. The animals continued to die with fairly short intervals between deaths. It was not until December 2, 1933 that in a Holstein-Friesan bull named Martin the infection was first disclosed.

This animal had been turned loose in a nearby pasture and at about two o'clock in the afternoon on December 2, 1933 he suddenly developed very violent symptoms. The bull ran from one end of

the pasture to the other tearing down fences and throwing himself on the ground. After breaking several ropes the animal was controlled. Its temperature was 41.5°C., pulse was fast and shallow, hemoglobin, 9.5 grams per 100 ml. of blood. Smears taken from the ear vein disclosed the presence of numerous *Trypanosome* organisms. The bull died at about three o'clock in the morning of the following day. Very early in the morning on this same day, December 3, 1933, the herdsman found cow No. 151 named Elsie in a very serious condition. When seen by the writer she was prostrate on the ground with head fully extended and moving only her legs. Her temperature was 41.0°C., pulse rapid and shallow. Blood smears taken from the ear vein were teeming with *Trypanosome* organisms. Samples of these *Trypanosomes* taken directly from the animal and through inoculated white rats were sent to Dr. M. A. Tubangui of the Bureau of Science for identification. Doctor Tubangui reported that the *Trypanosomes* which he found were identical to type *evansi*, the protozoa that cause surra.

A thorough survey was started to determine the extent of the infection of surra among the animals in the Department of Animal Husbandry, College of Agriculture. All horses, oxen, water buffaloes, sheep and goats were subjected to microscopic examinations for the presence of the *Trypanosomes*. Some pigs were also examined. The results of this survey are given below:

First complete test: December 5, 1933 to January 3, 1934

KINDS	NUMBER OF ANIMALS EXAMINED		
	Total	Negative	Positive
Horses	10	10	None
Oxen	119	107	12
Water buffaloes	64	57	7
Sheep	15	15	None
Goats	35	35	None
Pigs	7	7	None

Second complete test: January 4 to 18, 1934

Horses	10	9	1
Oxen	107	106	1
Water buffaloes	57	54	3
Sheep	15	15	None
Goats	35	35	None
Pigs	5	5	None

Third complete test: January 19 to February 7, 1934

KINDS	NUMBER OF ANIMALS EXAMINED		
	Total	Negative	Positive
Horses	9	8	1
Oxen	106	106	None
Water buffaloes	54	49	5
Sheep	15	15	None
Goats	35	35	None

METHODS OF CONTROL

In the absence of specific curative and preventive treatments against the disease and because at that time the Department of Animal Husbandry did not have facilities for keeping surra infected animals on its premises, the measures taken to prevent rapid spread of the infection was the destruction and proper disposal of all animals found positive under the microscope. This method was strictly adhered to until February, 1934.

Arrangements were made with the U. S. Army Medical Research Board for the testing of the animals in the department by the complement fixation test. On January 26, 1934, Major Raymond Randall and Lieutenant A. T. Thompson of the Research Board came to the College to get some samples for the test. They were accompanied by Colonel Geo. H. Koon of the U. S. Army Veterinary Hospital. Eighty-six animals were tested of which 58 were oxen and the remaining 28 were Native carabaos and Indian buffaloes. The report which they submitted showed that 60.34 per cent of the oxen tested and 42.85 per cent of the water buffaloes were positive for surra. The test, however, disclosed that some herds both of oxen and of water buffaloes were entirely free from the infection.

In one of the Department conferences regarding the measures to be taken in the control and eradication of the disease, the following program was approved in principle:

Program of the work regarding surra

Objective: The purpose of the work shall be to completely stamp out the disease from the Department. For the purposes of this work all the animals on the Campus shall be considered as having been exposed to the disease. The methods to be employed will be the following:

1. Microscopic examination of the blood of all animals belonging to the department once a week in herds that have shown a high percentage of infec-

tion as detected by the complement fixation tests, less frequently in those that were found negative.

2. Animals found positive by microscopical examination shall be quartered in the Isolation Barn made fly proof by wire screens. Animals giving positive reaction to rat inoculations even though *Trypanosome* negative by blood smears shall be placed in this Isolation Barn. Animals in this barn will be subjected to daily blood examination and the progress of the disease carefully observed.

3. Animals that maintain infection or become worse because of the infection shall be disposed of either by destruction or used for experimental purposes. Those that overcome infection, judged on the bases of improved condition and by microscopic examination of the blood, shall be subjected to complement fixation tests and by animal inoculations. If negative by animal inoculations in a minimum of three tests they may be returned to their respective herds provided that their condition warrants such action.

4. If animals overcome paroxysm and are negative under the microscope, but positive by animal inoculation, and are in good condition, they may be slaughtered unless they are valuable for breeding purposes.

It may be seen from the foregoing program that while only departing as to time from the general plan of outright destruction of animals which may serve as reservoirs of infection still the objective has remained the same, that is, the stamping out of the disease completely. That some progress has been obtained in the work may be seen in the following table which shows the number of animals found infected under the microscope by monthly intervals from February to October, 1934, inclusive:

MONTHS	KIND AND NUMBER OF ANIMALS FOUND INFECTED		
	Oxen	Water buffaloes	Horses
1934			
February	3	2	None
March	None	2	None
April	5	1	None
May	1	None	None
June	None	2	None
July	2	1	None
August	1	None	None
September	None	None	None
October	None	None	None

POSSIBLE SOURCES OF INFECTION

The question may now be asked: How was the infection introduced into the herds of the Department? It is common knowledge that surra is widespread in the Philippines, having been reported

in practically all provinces from time to time. Isolated cases have been found in the province of Laguna, particularly among horses in the towns of Biñang, Sta. Rosa and Calamba, and in Calauan it is said that it is difficult to raise horses because the oxen and carabaos are infected with surra. In other provinces, however, as Batangas some towns are said to have never been invaded by the disease. Edwards (1916) reports that certain districts are entirely free from surra.[3]

An outbreak of surra occurred among horses belonging to the Department of Animal Husbandry, College of Agriculture, in 1919. This outbreak was definitely traced to surra infected horses brought from Manila for use in veterinary anatomy classes in the College of Veterinary Science. The disease, however, was soon eradicated by outright destruction of all animals found positive under the microscope. From 1919 to the present outbreak the disease had not been detected in any of the animals of the department.

Extensive experimental studies on the curative treatment of surra in Native horses were started in the College of Veterinary Science in February, 1932, and when the College was moved back to Manila in May, 1933 the experiments were in progress. Some 28 horses and many laboratory animals, such as white rats and guinea pigs were used in the experiments. At suitable periods, after artificial infection, the horses were given chemotherapeutic agents and some of them had been apparently cured but relapses have been reported.[4]

It was on June 14, 1932,[5] while the experiments just mentioned were still in progress, that the work carabao named Homer, No. 48, belonging to the College of Agriculture, was taken to the Clinics of the College of Veterinary Science for treatment for horn fracture. The report on the case (Agudo, 1934) states that the animal was used for plowing the cultural fields of the U. P. Rural High School located in close proximity to the College of Veterinary Science and the fracture, breaking of right horn near the base, occurred when it fell violently to the ground in a struggle to disentangle its feet from a rope. The animal became an in-case in the

---

[3] EDWARDS, C. W. 1916. The live stock industry of the Philippines. The Philippine Agric. Rev. 9: 136–149. 5 plates.

[4] YUTUC, LOPE M. 1934. Experimental studies on the curative treatment of surra in Native horses in the Philippines. Philippine Jour. Sci. 54: 9–27.

[5] AGUDO, EUGENIO. 1934. Report to the Head of the Department of Animal Husbandry, College of Agriculture.

Veterinary Hospital and stayed there continuously for thirteen days. Thereafter up to the middle of July, 1932 it became an out-case but was taken to the Veterinary Clinics every day for treatment. When not in the Clinics it was herded with other work animals in the pasture lots of the Rural High School. Mr. Agudo who had direct supervision of the animal in question states that the core did not heal completely until the early part of June, 1933. In the period intervening this carabao had to be taken to the College of Veterinary Science at irregular intervals for treatment. This carabao was found to be heavily infected with surra and all the animals that were herded with it disclosed the *Trypanosome* organisms in the peripheral blood.

At times, when necessity demanded, some of the work animals of the Rural High School had been taken to the culture lots of the Department of Animal Husbandry and were used, when needed, with other work animals of the Department in plowing the fields preparatory to planting rice or corn. Also, it is the practice in the department to take such data as weights and other measurements of its animals at the end of every month. The herds are brought in succession into the weighing corral constructed specially for the purpose. Indeed, it would not be surprising if the infection of other herds occurred in this way. For purposes of controlled breeding and management, the different classes and breeds of animals are divided into separate herds. In the following table the location of these herds and the degree of infection of surra are shown.

Table showing the herds of animals of the Department of Animal Husbandry, the pastures where these herds are located and the intensity of infection of surra

HERDS	LOCATION	DEGREE OF INFECTION
Agronomy work animals	Experiment Station grounds	Light infection
Breeding water buffaloes (Native carabaos and Indian buffaloes)	Tanza pasture B	Not infected
Dairy cows .... (Oxen and water buffaloes)	Department premises and Tungtuñgin pastures Nos. 1-B and 2-B, alternated	Heavy infection
Hereford cattle	Pinagtulusan pasture No. 1-B ..	Very heavy infection
Holstein-Friesian cattle.	Department's premises and Tungtuñgin pastures 1-A and 2-A, alternated	Light infection
Indian Nellore cattle ...	Pinagtulusan pasture No. 2-B ..	Heavy infection
Philamin cattle	Almira pasture No. 2-A and 2-B. alternated	Light infection

HERDS	LOCATION	DEGREE OF INFECTION
Philippine native cattle	Almira pasture No. 1-B	Light infection
Reserved bulls and steers	Tanza pasture A	Not infected
Rural High School work animals	Pag-itan pastures	All animals infected
Horses	Kept in runs near Animal Husbandry Building when not in stalls	Light infection
Red Scindi cattle	Kept in screened barns	Not infected
Sheep and goats	Kept in the goat barn when not in nearby pastures	Not infected

It may be seen in the foregoing table that some of the herds have remained uninfected to this day. The free herds of breeding water buffaloes and reserve bulls and steers did not come into frequent association with the animals used for work or for dairy. These animals in the Tanza pastures have been tested regularly every month from December, 1933 to date, by microscopic examination, and no *Trypanosomes* have been found. Repeated complement fixation tests for surra both by the U. S. Army Medical Research Board and the Bureau of Animal Industry have all given negative results. These findings are extremely significant in view of the fact that the Native carabaos used for logging at the School of Forestry as well as the privately owned horses and water buffaloes in the Coffee Plantation of the College of Agriculture which were never at any time in association with any of the animals in the department have not shown any *Trypanosome* organisms in repeated microscopic examination, and no epizootic of surra among oxen or horses has been known to occur in the vicinity of the College of Agriculture since 1919. Our observations (covering 11 months at the writing of this paper, and being continued for future reports) on the incidence of *Tabanid* flies indicate that these flies are present on the College of Agriculture Campus at all times. The only time we did not get any flies was when we did not go out to collect them. Kelser (1927)[6] states that *Tabanus striatus* are exceedingly hard to find in the vicinity of Manila in certain months. Perhaps, the habits of *Tabanid* flies are different in different localities.

SYMPTOMS OF THE DISEASE

Among the taurine cattle both acute and subacute manifestations of the disease were observed. The acute cases were charac-

[6] KELSER, R. A. 1927. Transmission of surra among animals of the equine species. Philippine Jour. Sci. 34: 115–139. 2 plates.

terized by the sudden appearance of violent symptoms accompanied by rapid and labored breathing. The heart throbbed and the pulse was frequent and shallow. The temperature varied from 40.0 to 41.5°C. In subacute cases the symptoms were not very striking. The affected animals lost weight progressively and emaciation was rapid. Death occurred from 18 to 50 days from the time the organisms were first detected in the peripheral circulation.

An enormous amount of data on the temperature of surra infected and non-infected animals has been accumulated. In the oxen that were found positive both by the complement fixation tests and under the microscope the temperature ranged from 37.3 to 41.8°C., the mean being 39.11 ± 0.061°C.; δ, 0.826 ± 0.042°C.; and c.v., 2.11 ± 0.111 per cent. In those that were negative by the complement fixation tests and had never exhibited the *Trypanosome* organisms under the microscope, that is, the non-infected, the range of temperatures was 37.8 to 39.3°C. with the mean at 38.66 ± 0.061°C.; δ, 0.564 ± 0.451°C.; and c.v., 1.45 ± 0.011 per cent. The difference of the means was 0.45 ± 0.084°C. showing the existence of fever in the surra infected oxen.

This fever, however, was not continuous. During the periods when *Trypanosome* organisms were not in the peripheral circulation the mean of temperatures was 38.55 ± 0.041°C.; δ 0.53 ± 0.029°C.; and c.v., 1.37 ± 0.076 per cent. During the periods of paroxysms when the *Trypanosomes* were in the peripheral circulation the mean of temperatures was 39.54 ± 0.125°C.; δ, 0.83 ± 0.087°C.; and c.v., 2.12 ± 0.220 per cent. These data show that during the periods of paroxysms the temperatures were not only significantly higher but were more variable than during the latent periods as indicated by the coefficients of variability; namely, 2.12 ± 0.220 per cent and 1.37 ± 0.076 per cent, respectively.

A similar situation obtained among water buffaloes. In the non-infected the mean of temperatures was 38.26 ± 0.087°C., and 38.60 ± 0.026°C. in the infected animals. During the periods when the organisms were present in the circulating blood the mean of temperatures was 38.85 ± 0.061°C.; at other periods it was 38.54 ± 0.028°C. The differences between these means were all significant in showing that as, with the oxen, the temperatures in the water buffaloes rise, as a result of *Trypanosome* infection but the fever disappears periodically as the organisms recede from the peripheral circulation.

THE EFFECT OF DIFFERENT METHODS OF PLANTING ON BATANGAS WHITE COTTON [1]

EULALIO P. BALTAZAR AND GRACIANO D. ESPINUEVA

In the United States the effect of spacing on the yield of cotton has been studied by such investigators as Hastings (1916), Letteer (1917-18), Meade (1917), Ware (1930), Hinds (1928) and Stansel (1917). Although the climate and soil conditions of the Philippine Islands are favorable for cotton production, not much work has been done on the growing of the crop. Problems relating to effects of distancing and number of plants to a hill on its yield have received little or no attention.

Because of present interest in the Philippines to revive and increase the cotton industry in this country, it is important that there be some investigation on factors affecting the yield of the cotton plant. With this end in view the present work was undertaken.

REVIEW OF IMPORTANT LITERATURE

Meade (1915) compared normally thinned Acala spaced 60.96 cm. apart in the row with late-thinned Acala spaced 15.24 to 20.32 cm. apart in the row. He observed that the close-spaced late-thinned Acala gave better results than the wide-spaced normal Acala.

Letteer (1916-1917) found that the wide-spaced early thinned plants yielded better than the late thinned close-spaced plants. He expressed the belief, however, that this difference was due to the adverse climatic conditions at the time he carried out his investigations.

Tisdale (1928) studied "the effect of one, two, three and four plants per hill left at spacings of 15.24, 30.48, 45.72, 60.96, 76.20 and 91.44 cm. One-half of each plot was left unfertilized and the other half received 673.62 kgm. of super-phosphate (acid phosphate), 56.12 kgm. of muriate of potash and 136.36 kgm. of nitrate

[1] The greater part of the data in this paper was in a thesis prepared under the direction of the senior author and presented by the junior author for graduation, 1934, from the College of Agriculture, with the degree of Bachelor of Science in Agriculture. Thesis No. 441; Experiment Station contribution No. 1005. This paper was revised by the senior author.

Received for publication May 4, 1934.

of soda per hectare. He found that the average results showed that on both the fertilized and unfertilized land the largest yields were made from spacings of 60.96 and 45.72 cm. in the drill with two plants per hill," or 12,445 and 16,592 plants per 0.407 Ha., respectively.

Mooers (1928) reported "that there is a positive and progressive increase in the yields of fiber from the 7.62 cm. to 30.48 cm. spacing, that from the 30.48 cm. through the 54 cm. of spacing the yields are constant with an average of 260.46 kgm. per Ha. and that from the 53.34 cm. to the 91.44 cm. spacing there is a consistent decrease in yield."

Hinds (1928) studied "the effect of the spacing of cotton upon the form and height of the plant." He found that the widest spacing, single plants 60.96 cm. apart, produced invariably the lowest and broadest growth with thickened bases to the stalks, heavy vegetative branches, and delayed setting of bolls. Hill spacing with 3 to 5 at 30.48 cm. to 38.10 cm. apart appeared to give the most practical and desirable spacing."

Stansel (1925) reported that the effect of spacing on yield of cotton favored the close spacing and medium distancing. The 15.24 cm. to 53.34 cm. gave the best results, the optimum spacing being dependent upon the soil and climatic conditions and also upon the variety of cotton grown.

Mendoza (1922) found under Los Baños conditions that in plantings made in November and December at a distance of 120 cm. each way using one plant to a hill, the highest yields ranged from 48.2 to 125.00 grams of fiber to each plant. Plantings made later than December were not profitable.

OBJECTS OF THE PRESENT WORK

The objects of the present work were: (*a*) to determine the right distance of planting cotton plants and the right number of plants to a hill at a given distance under Los Baños conditions; and (*b*) to determine the effects of distance of planting and number of plants to a hill on the growth, fruiting characteristics and yield of the Batangas cotton plant.

TIME AND PLACE

This study was conducted in the Experiment Station grounds and in the Seed House of the Department of Agronomy, College of Agriculture, Los Baños, Laguna, beginning June, 1933 and closing February, 1934.

MATERIALS AND METHODS

Variety of cotton used

The variety of cotton used in this study was Batangas White obtained from the Bureau of Plant Industry, Manila. Two kilograms of seeds were bought at ₱0.40 a kilogram.

Preparation of the land

The soil used is clay loam. The land was first plowed in June, 1933 with the Luzon Lagio plow and harrowed one day later with the ordinary upland harrow. The operation was repeated three times. The last plowing and harrowing were in the early part of August, 1933. After it was thoroughly prepared, the land was divided into 60 plots, 45 with dimensions of 2 × 10 meters, and 15 which measured 2.20 × 10 meters. The field was 54 meters long and 34 meters wide, and covered an area of 1,836 square meters.

Planting

The percentage of germination of the seeds was tested and found to be 76. The seeds were soaked in water for one night before they were planted.

There were 20 plots in each of lots 1, 2, and 3. In the first 5 plots the hills were distanced 75 cm. in the rows and 50 cm. between the rows, with 5 rows to each plot; the second 5 plots, 75 cm. by 100 cm., had 3 rows to each plot; the third 5 plots, 100 cm. × 100 cm. had 3 rows; and the fourth 5 plots, 100 cm. × 100 cm. had 3 rows. In all of these plots, three seeds to a hill were planted. In lot 2 the same distances of planting were used but four seeds were planted to a hill. In lot 3 the same distances of planting were followed but five seeds were planted to a hill. Five replications, arranged in a checker board fashion were used for every treatment in this experiment. Three days after planting, the seeds began to germinate.

Field operations

Weeding. One week after germination, the first weeding was done; weeding was continued until the blooming stage. The field was weeded at least three times a week. Trowels and hoes were used.

Cultivation. Shallow cultivation was given once a week. The soil was pulverized to properly aërate it and kill the weeds. Cultivation was continued until the plants began to flower.

Thinning. The seedlings were thinned to one plant to a hill in lot 1; 2 plants to a hill in lot 2; 3 plants to a hill in lot 3. Thinning was done when the seedlings were about 10 cm. above the surface of the ground.

Watering. Watering the cotton plants was not necessary because the soil was moderately moist during their vegetative growth.

Methods of obtaining data

Height. In measuring the height of the plants, a peg to serve as base mark was stuck near the base of each plant. The top of each base mark was about one cm. above the surface of the ground.

With the meter stick the height of the plant was measured from the base mark to the terminal bud of the cotton plant. During the last picking, the vertical heights of one thousand two hundred plants, ten plants from each plot taken at random from the different plots, were measured.

Lateral expansion. The greatest breadth of each plant was measured for the lateral growth or expansion of the cotton plants. Twenty plants were measured in each of the 60 plots under study.

Mode of growth. The cotton plants varied in their mode of growth. Some were tall in growth, others were short and stunted. Also they varied in form or shape of crown, as some were pyramidal, others had open center, and still others were forked in form. All types of growth of the crowns were observed and recorded.

Fruiting characteristics. When they were about 30 days old the bolls were measured with a micrometer caliper. Twenty bolls from each of the 60 plots were selected at random and their lengths and widths measured and recorded. In all, 1,200 bolls were measured.

Harvesting

Time of harvesting. Harvesting was begun when the bolls had opened. The first harvest was made on January 7 and the last one on February 10, 1934.

Average number of bolls produced per plant. The total number of bolls harvested from one plot at a given distance of planting and a given number of plants to a hill was recorded. The average number of bolls produced by one plant was determined by dividing the total number of bolls harvested by the total number of plants grown in this particular plot.

Percentage of lint. The percentage of lint was found by dividing the total weight of clean lint by the total weight of bolls from which the lint was obtained and multiplying by 100.

Length of lint. The length of lint was determined by carefully pulling the fibers from a boll and laying them one by one on a moistened slide, 3 cm. wide and 10 cm. long. The exact length of one fiber was taken by carefully stretching it on the moistened slide with the use of a pair of dissecting needles. Twenty fibers taken from 20 different bolls taken at random were measured. The data obtained represent the actual length of the lint harvested from one given plot. The same procedure was followed in determining the actual length of the lint obtained from the other plots.

Percentage of seeds. The percentage of seeds was obtained by dividing the total seed weight by the total weight of the bolls under study and multiplying the quotient by 100.

Percentage of other parts of bolls. The total weight of bolls minus the combined weight of seeds and lint gives the weight of the capsules under investigation. The weight of the capsules was divided by the total weight of the bolls and multiplied by 100 to obtain the percentage of the capsules.

Yield

The yields of bolls, lint and seeds from each plot were separately determined and recorded. This was done so as to be able to compare the effect of distancing and number of plants to a hill on the yield and fruiting characteristics.

Diseases and pests

Among some of the organisms causing diseases observed on the cotton plants in the field were:

Pythium debaryanum. The micro-organisms causing this particular kind of disease attacked the young plants at the base near the surface of the ground, causing them later to rot off.

Heterodera radicicola. The worms enter the roots of the cotton plants, causing galls or swellings in them.

The most common insect pests of cotton observed during the progress of this study were:

Dysdercus megalopygus Bredd. This is known as the oriental cotton stainer. It is called *bacabaca* by the Ilocanos and *bacabacahan* by the Tagalogs. This insect stains the lint of the cotton yellow.

Dysdercus poecilus H. S. This insect is known as *bacabaca* by the Ilocanos and *bacabacahan* by the Tagalogs. It sucks the juice of the immature boll and stains the lint yellow.

Tectocoris lineola Fabr. This is a large red insect. It measures 1 centimeter long and about 1 centimeter wide. It sucks the sap of the young shoot of the cotton plant.

Heliothis obsoleta Fabr. This is an important cotton pest. The larva feeds on the flowers and bolls of the cotton plant.

The attacks of the fungi and insect pests mentioned above are believed not to have affected the comparative results of this experiment because the attacks were not serious and appeared to be the same in degree in the different plots compared.

EXPERIMENTAL RESULTS

The results of this work are given in tables 1 to 10.

Table 1 shows the height and lateral growth of fifty plants selected at random under each treatment during the last picking.

Table 2 gives the data on the mode of growth of the cotton plants as affected by distancing and number of plants to a hill.

In table 3 are presented the data on the growing period requirement for blooming and fruiting cotton as affected by distancing and number of plants to a hill.

In table 4 are shown the data on the size of bolls under different treatments. The mean length and diameter of 100 bolls representing the different treatments in the field are given in this table.

In table 5 are shown the data on the average number of bolls produced by each plant, weight of each boll, and length of lint under each treatment.

Table 6 shows the actual yields of the different plots as affected by different treatments.

Table 7 gives the percentage and average yield in capsules, lint and seeds for each treatment.

Table 8 presents the actual yield in lint in each plot and the computed yield per hectare.

In table 9 are shown the data on the summary of the effect of distancing and number of plants to a hill on yield of lint per hectare.

In table 10 are presented the differences of the effects of the different treatments on the yield of lint per hectare.

DISCUSSION OF RESULTS

According to the data presented in table 1 there seems to exist a close relation between mean height and mean lateral growth of

the cotton plants with distance of planting. As a general rule, the closer the distance of planting, the less the growth of the cotton plant in height and in lateral expansion and vice versa. Plants distanced at 75 cm. $\times$ 50 cm. and one plant to a hill gave an average mean height of 119.72 $\pm$ 1.42 cm. and a mean lateral growth of 60.40 $\pm$ 0.96 cm.; two plants to a hill, 107.20 $\pm$ 1.20 cm. and 45.50 $\pm$ 1.14 cm.; and three plants to a hill, 114.60 $\pm$ 0.93 cm. and 42.60 $\pm$ 0.195 cm. The difference in growth is due to the different distances of planting, for the greater the distances of planting, the greater the chance of the plants to make vegetative development.

It is interesting to note in table 2 that the number of plants to a hill greatly influenced the mode of growth of the cotton plants, for it is clearly seen from the data that in one plant to a hill, regardless of the distances of planting, the most common mode of growth was pyramidal. Out of 400 plants studied, 219 plants were pyramidal, 69 center headed, 62 open center, and the rest forked and two stories. Those cotton plants planted two plants to a hill exhibited another type of growth, cylindrical being the most common. The prevailing mode of growth among those cotton plants planted three plants to a hill was lopsided, as 249 out of 400 plants showed this form. The variety of growth exhibited by the cotton plants was due to the position and relation of the different individuals with one another in the field and to the influence of light as affected by the closeness of the planting. It is shown in this table that it is most likely that it was not the distance of planting that influenced the mode of growth of the cotton plants, but the number of plants to a hill that caused them to assume a certain type of growth.

It may be noted in table 3 that regardless of the number of plants to a hill, the closer the distance of planting, the earlier were formed the squares, flowers and bolls, and vice versa. This effect was found to be true in every distance of planting tried in this study. The plants planted at greatest distances have more room for vegetative growth; this expansion arrests their reproductive growth, hence a longer time is required for the maturing of squares, flowers and bolls.

As shown in table 4, regardless of the number of plants to a hill, it is evident that there is a direct relation between distance of planting and size of bolls produced by the cotton plants under different treatments. The data of two plants to a bill as shown in table 4 show the average size of bolls in the different distances of 75

$\times$ 50 cm.; 75 $\times$ 100 cm.; 100 $\times$ 100 cm.; and 100 $\times$ 110 cm. The length and width of bolls were: 4.97 $\pm$ 0.0263 cm., 3.45 $\pm$ 0.0136 cm.; 5.16 $\pm$ 0.0409 cm., 3.54 $\pm$ 0.0100 cm.; 5.24 $\pm$ 0.0675 cm., 3.55 $\pm$0.009 cm.; and 5.32 $\pm$ 0.065 cm., and 3.57 $\pm$ 0.0106 cm., respectively.

In every case, the closer the distance of planting, the smaller was the size of bolls produced. The greater distance of planting produced larger growth, both vegetative and reproductive.

The least mean length and diameter of bolls were produced by those plants planted closest, and the greatest, by those plants planted farthest apart.

It may be seen in table 5 that although closer distancing produced the larger number of bolls, the weight of each boll was less than those produced by greater distancing. Greater distancing produced a smaller number of bolls per given area but bolls larger in size. Although there seems to exist no close relation between distancing and number of bolls produced by one individual plant, the data seem to show that the greater the distancing, the larger the number of bolls produced by one plant.

There seems to be no close correlation between distancing and number of plants to a hill and length of lint, as shown by the data presented in table 5, although there is a slight tendency for the cotton plants to produce longer lint when planted farther apart.

It may be seen in table 6, that except in one case, the larger number of bolls and greater weight of lint were produced by plants planted one plant to a hill, not by plants from hills that had two or three plants to a hill. As shown in table 6, one plant to a hill distanced 75 $\times$ 50 cm. gave an average yield of bolls of 224 and an average yield of lint of 246.8 grams; two plants to a hill the same distancing gave 182 bolls and 184 grams of lint; and three plants to a hill the same distancing gave 207 bolls as average yield to a plot and 204.90 grams of lint. This difference was found to be true in all cases except with those plants planted at a distance of 100 $\times$ 110 cm. The greater production by plants planted one plant to a hill than from those planted two or three plants to a hill regardless of the distance of planting was due to the greater size attained by the one plant to a hill and to the larger bolls that these plants produced. According to the data presented above, the best distance of planting was 75 $\times$ 50 cm., one plant to a hill.

The data presented in table 7 seem to show that although, apparently, there is no close correlation between distancing and number of plants to a hill with the percentage and average yield of cap-

sules, lint and seed from each treatment, in all cases regardless of the number of plants to a hill, those planted at a distance of 75 × 50 cm. produced the highest percentage and average yield of capsules, lint and seed. This result was undoubtedly due to the larger number of plants in the plots under investigation, as the distance of planting was closest.

The data given in table 8 show no direct relation between distancing and number of plants to a hill and actual yield of lint from each plot, but it is interesting to note that regardless of the number of plants to a hill, those plants planted at a distance of 75 × 50 cm. produced the greatest weight of lint both per plot and per hectare.

It may be seen in table 9 that there is a direct correlation between the yield of lint per hectare and distancing and number of plants to a hill. Cotton plants planted at a distance of 75 × 50 cm. and one plant to a hill gave a yield of 123.34 ± 7.838 kgm.; two plants to a hill, 92.02 ± 4.506 kgm.; three plants, 102.50 ± 6.222 kgm. Those cotton plants planted at a distance of 100 × 110 cm. and 1, 2, 3 plants to a hill gave the lowest yield, being 81.76 ± 4.627, 66.90 ± 2.90, and 66.24 ± 2.503 kgm., respectively. This assumption is further supported by the data presented in tables 6, 7 and 8.

As shown by the data given in table 10, there is a correlation between distancing and number of plants to a hill and differences of two means in yield of lint per hectare between one and two plants to a hill at a distance of 75 × 50 cm.; one and three plants to a hill at a distance of 100 × 110 cm. The 75 × 100 cm. and 100 × 100 cm. did not show any correlation because the results were all insignificant, although differences existed among them. The greatest difference was exhibited between the one plant to a hill planted 75 × 50 cm. and the two plants at the same distance. This difference of 31.24 ± 9.041 which is significant in favor of one plant to a hill and also one plant, distanced 100 × 110 cm., gave a difference of 15.52 ± 5.26 which is significant in favor of one plant to a hill over three plants to a hill at the same distance. This superiority is due to the very great margin of number of bolls and weight of lint produced by plants planted at a distance of 75 × 50 cm. over plants planted farther apart.

SUMMARY

1. Using distances, 75 × 50 cm.; 75 × 100 cm.; 100 × 100 cm.; and 100 × 110 cm. in cotton planting, it was found that the closer the planting, the less was the growth of the cotton plants, both in vertical height and in lateral expansion.

2. The most common type of crown among plants planted one plant to a hill was pyramidal, among two plants to a hill, cylindrical, and among three plants to a hill, lopsided.

3. The closer the planting, the earlier the squares, flowers and bolls were formed, and vice versa.

4. The closer the planting, the smaller the size of the bolls produced.

5. Close planting produced a larger number of bolls but smaller ones than those produced by plants planted farther apart.

6. In most cases a larger number of bolls and greater weight of lint were produced by plants planted one plant to a hill, regardless of the distance of planting, than by those plants planted two or three plants to a hill.

7. Closer planting gave the better yield of capsules, lint, and seeds.

8. The best distancing was found to be 75 × 50 cm.

9. The most common disease which attacked young cotton plants in this work was damping-off.

10. The most common insect pest which attacked cotton bolls in this work was the oriental cotton stainer.

LITERATURE CITED

HASTINGS, S. H. 1916. Work of the San Antonio Experiment Farm in 1915. U. S. Dept. Agric. Circ. 10: 13–14.

HINDS, W. E. 1928. The effect of spacing of cotton upon the form and heights of the plant. Jour. Econ. Entomol. 21: 741–748.

LETTEER, C. R. 1917. The work of the San Antonio Experiment Farm in 1916. U. S. Dept. Agric. Circ. 16: 11–12.

LETTEER, C. R. 1918. The work of the San Antonio Experiment Farm in 1917. U. S. Dept. Agric. Circ. 21: 13–14.

MEADE, R. M. 1915. Single stalk cotton culture at San Antonio. U. S. Dept. Agric. Bull. 279: 1–20.

MENDOZA, F. M. The growth and yield of fiber of cotton plant as influenced by distancing and time of planting. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture, College of Agriculture, 1922. Unpublished.)

MOOERS, C. A. 1928. The effect of spacing on the yield of cotton. Jour. Amer. Soc. Agron. 20: 211–229.

STANSEL, R. H. 1927. The effect of spacing and time of thinning in the yield, growth, and fruiting characteristics of cotton plant in 1925. Texas Agric. Exper. Sta. Bull. 960: 1–38.

TISDALE, H. B. 1928. Effect of spacing and size of cotton bolls. Jour. Amer. Soc. Agron. 20: 298–301.

WARE, J. O. 1930. Cotton spacing. Arkansas Agric. Exper. Sta. Bull. 253: 1–17.

TABLE 1

Mean height and lateral growth of fifty plants selected at random under each treatment during the last picking

PLOT NO.	DISTANCE OF PLANTING	PLANTS MEASURED	ONE PLANT TO A HILL		TWO PLANTS TO A HILL		THREE PLANTS TO A HILL	
			Mean height	Mean lateral growth	Mean height	Mean lateral growth	Mean height	Mean lateral growth
	cm.	*number*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
5	75 × 50	50	119.72 ± 1.42	60.40 ± 0.96	107.20 ± 1.20	45.50 ± 1.14	114.60 ± 0.93	42.60 ± 0.952
5	75 × 100	50	120.60 ± 1.48	59.15 ± 1.03	110.00 ± 1.52	48.00 ± 1.24	118.00 ± 2.67	51.60 ± 0.509
5	100 × 100	50	114.90 ± 2.16	63.50 ± 1.14	119.60 ± 1.19	62.00 ± 1.45	122.00 ± 1.28	54.32 ± 1.041
5	100 × 110	50	128.70 ± 1.74	70.76 ± 1.80	111.70 ± 1.80	60.20 + 1.49	121.00 + 1.77	57.40 + 0.936

TABLE 2

Mode of growth of cotton plants as affected by distancing and number of plants to a hill

PLOT NO.	DISTANCE	PLANTS TO HILL	PLANTS STUDIED	PYRAMIDAL	CENTER HEADED	OPEN CENTER	FORKED	TWO STORIES	LOPSIDED	CYLINDRICAL
	cm.	*number*	*number*	*number*	*number*	*number*	*number*	*number*	*number*	*number*
5	75 × 50	1	100	55	15	14	10	6	—	—
5	75 × 100	1	100	53	19	13	8	7	—	—
5	100 × 100	1	100	53	18	19	7	6	—	—
5	100 × 110	1	100	58	17	16	4	5	—	—
Total	—	—	400	219	69	62	29	24	—	—
5	75 × 50	2	100	—	17	5	4	4	23	47
5	75 × 100	2	100	1	13	7	4	4	17	55
5	100 × 100	2	100	4	14	9	3	4	13	52
5	100 × 110	2	100	6	12	12	2	5	16	47
Total	—	—	400	11	56	33	13	17	69	201
5	75 × 50	3	100	—	18	1	2	8	66	6
5	75 × 100	3	100	—	16	—	6	7	65	7
5	100 × 100	3	100	3	19	—	7	7	61	4
5	100 × 110	3	100	4	17	—	8	9	57	5
Total	—	—	400	7	70	1	23	31	249	22

TABLE 3

Growing period requirement for blooming and fruiting as affected by distancing and number of plants to a hill[a]

DISTANCE OF PLANTING	ONE PLANT TO A HILL			TWO PLANTS TO A HILL			THREE PLANTS TO A HILL		
	First square	First bloom	First open boll	First square	First bloom	First open boll	First square	First bloom	First open boll
cm.	*days*	*days*	*days*	*days*	*days*	*days*	*days*	*days*	*days*
75 × 50	32	63	125	32	63	125	30	62	124
75 × 100	34	64	126	33	65	126	31	63	126
100 × 100	35	65	128	34	65	128	32	64	127
100 × 110	37	66	131	36	66	130	35	64	129

[a] Figures in all columns under "days" is the growing period for plants in that section.

TABLE 4

Size of bolls under different treatments

PLOT NO.	BOLLS MEASURED	75 CM. × 50 CM.		75 CM. × 100 CM.		100 CM. × 100 CM.		100 CM. × 110 CM.	
		Length	Diameter	Length	Diameter	Length	Diameter	Length	Diameter
One plant to a hill									
	number	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
1	20	5.02	3.58	5.13	3.68	5.18	3.68	5.34	3.65
2	20	5.03	3.56	5.11	3.65	5.16	3.65	5.35	3.67
3	20	5.00	3.55	5.14	3.67	5.19	3.68	5.38	3.64
4	20	4.94	3.53	5.12	3.64	5.18	3.67	5.36	3.68
5	20	5.06	3.51	5.11	3.62	5.17	3.65	5.32	3.65
Total ...	100	25.05	17.79	25.61	18.26	25.88	18.33	26.75	18.29
Av.	20	5.01±0.0126	3.56±0.0075	5.12±0.0051	3.65±0.0082	5.18±0.0674	3.67±0.0064	5.35±0.0075	3.66±0.0041
Two plants to a hill									
1	20	5.02	3.47	5.18	3.57	5.25	3.55	5.32	3.59
2	20	5.00	3.45	5.16	3.54	5.23	3.54	5.30	3.57
3	20	4.86	3.45	5.16	3.54	5.27	3.58	5.33	3.58
4	20	4.97	3.46	5.17	3.54	5.24	3.56	5.32	3.56
5	20	5.03	3.40	4.92	3.55	5.23	3.55	5.31	3.56
Total ...	100	24.88	17.23	25.79	17.73	26.22	17.78	26.58	17.86
Av.	20	4.97±0.0263	3.45±0.0136	5.16±0.0409	3.54±0.0100	5.24±0.0675	3.55±0.0090	5.32±0.0675	3.57±0.0106
Three plants to a hill									
1	20	4.96	3.38	5.20	3.51	5.22	3.53	5.33	3.59
2	20	4.91	3.35	5.18	3.50	5.20	3.51	5.31	3.58
3	20	4.94	3.37	5.16	3.48	5.23	3.55	5.32	3.59
4	20	4.92	3.35	5.19	3.52	5.16	3.49	5.28	3.57
5	20	5.03	3.41	4.95	3.47	5.15	3.46	5.30	3.58
Total ...	100	24.76	16.86	25.68	17.48	25.96	17.54	26.54	17.91
Av.	20	4.95±0.0143	3.37±0.0097	5.14±0.0065	3.49±0.0727	5.19±0.0067	3.51±0.0135	5.31±0.0067	3.58±0.0047

TABLE 5

Average number of bolls produced by each plant under each treatment, weight of each boll and length of lint

PLOT NO.	DISTANCE OF PLANTING	PLANTS TO A HILL	TOTAL PLANTS	TOTAL BOLLS	BOLLS TO A PLANT	AV. WT. OF ALL BOLLS	AV. WT. OF EACH BOLL	AV. LENGTH OF LINT
	cm.	*number*	*number*	*number*	*number*	*grams*	*grams*	*cm.*
5	75 × 50	1	348	1120	3.20	5592.80	4.90	2.85 ± 0.0270
5	75 × 100	1	210	945	4.50	5147.10	5.10	2.86 ± 0.0472
5	100 × 100	1	163	685	4.20	3451.60	5.20	2.90 ± 0.0337
5	100 × 110	1	147	720	4.90	4086.20	5.60	3.24 ± 0.0337
5	75 × 50	2	669	910	1.30	4417.80	4.90	2.88 ± 0.0405
5	75 × 100	2	418	714	1.7	4109.80	4.90	2.96 ± 0.0472
5	100 × 100	2	327	627	1.90	3264.60	5.20	2.96 ± 0.0539
5	100 × 110	2	300	607	2.00	3391.00	5.40	3.00 ± 0.0607
5	75 × 50	3	1047	1047	1.00	4979.90	4.80	2.88 ± 0.0405
5	75 × 100	3	630	819	1.30	4082.10	5.00	2.93 ± 0.0067
5	100 × 100	3	493	691	1.40	3498.10	5.10	3.19 ± 0.0270
5	100 × 110	3	449	585	1.30	3103.70	5.30	2.96 ± 0.0405

TABLE 6

Actual yields of different plots as affected by different treatments

PLOT NO.	AREA OF PLOT	YIELD OF EACH PLOT IN BOLLS, CAPSULES, LINT AND SEEDS: 75 cm. × 50 cm.					75 cm. × 100 cm.				
		Bolls	Weight of bolls	Weight of capsules	Weight of lint	Weight of seeds	Bolls	Weight of bolls	Weight of capsules	Weight of lint	Weight of seeds
	sq. m.	*number*	*grams*	*grams*	*grams*	*grams*	*number*	*grams*	*grams*	*grams*	*grams*
One plant to a hill											
1	20	292	1361.20	480.50	310.60	560.10	186	996.70	372.70	195.70	428.30
2	20	234	1288.50	434.70	294.60	559.20	196	1086.50	404.30	237.00	445.20
3	20	207	990.00	345.30	208.40	436.30	192	949.20	368.40	186.30	396.50
4	20	212	1037.70	358.30	222.20	457.20	221	1317.90	424.80	294.60	598.50
5	20	175	924.90	316.20	198.20	410.50	150	796.80	297.50	142.90	356.40
Total ...	100	1120	5592.30	1935.00	1234.00	2423.30	945	5147.10	1867.70	1056.50	2224.20
Av.	20	224	1118.40	387.00	246.80	484.00	189	1029.10	373.50	211.30	444.98
Two plants to a hill											
1	20	218	1069.10	358.30	236.30	474.50	149	923.10	296.00	203.40	403.70
2	20	169	773.20	247.60	158.50	367.10	164	884.80	279.70	192.20	412.90
3	20	186	915.40	309.70	189.00	416.70	135	780.80	258.10	159.00	363.70
4	20	176	855.60	291.00	170.40	394.20	142	830.20	267.40	176.40	386.40
5	20	161	804.50	267.40	165.80	371.30	124	690.90	232.90	132.90	325.10
Total ...	100	910	4417.80	1474.00	920.00	2023.80	714	4109.80	1334.10	863.90	1911.80
Av.	20	182	882.50	294.80	184.00	404.80	143	821.90	266.80	172.80	382.40
Three plants to a hill											
1	20	267	1251.60	402.40	263.40	585.80	142	766.30	252.40	156.30	357.60
2	20	189	977.30	301.90	183.90	491.50	211	951.60	335.20	214.00	402.40
3	20	228	1073.30	325.10	229.60	518.60	134	698.30	229.70	129.80	338.80
4	20	184	872.90	289.40	191.30	392.20	174	862.40	281.20	191.70	389.50
5	20	169	804.50	265.20	156.50	383.10	158	803.50	264.80	171.50	367.20
Total ...	100	1037	4979.90	1584.00	1024.70	2371.20	819	4082.10	1363.30	863.40	1855.50
Av.	20	207	995.90	316.80	204.90	474.20	164	816.40	272.60	172.60	371.10

TABLE 6 (continued)

One plant to a hill

PLOT NO.	AREA OF PLOT	YIELD OF EACH PLOT IN BOLLS, CAPSULES, LINT AND SEEDS									
		100 cm. × 100 cm.					100 cm. × 110 cm.				
		Bolls	Weight of bolls	Weight of capsules	Weight of lint	Weight of seeds	Bolls	Weight of bolls	Weight of capsules	Weight of lint	Weight of seeds
	sq. m.	*number*	*grams*	*grams*	*grams*	*grams*	*number*	*grams*	*grams*	*grams*	*grams*
1	20	121	679.80	164.60	147.60	217.00	132	760.30	256.50	152.10	351.70
2	20	154	722.70	288.20	192.40	286.40	178	1024.00	361.90	215.10	447.00
3	20	134	652.90	185.30	173.90	293.70	133	783.40	258.50	154.30	370.00
4	20	141	867.00	214.60	183.20	324.90	161	827.40	269.20	161.90	396.30
5	20	135	529.20	198.70	185.70	295.40	116	691.10	240.00	133.90	317.20
Total ...	100	685	3451.60	1051.40	882.80	1517.40	720	4086.20	1386.10	817.30	1882.80
Av.	20	137	690.30	210.30	176.60	303.40	144	817.20	277.20	165.40	376.50
Two plants to a hill											
1	20	124	663.40	219.20	157.70	286.50	141	780.00	263.70	148.10	368.20
2	20	136	833.60	256.10	189.50	388.00	108	608.50	195.40	121.70	291.40
3	20	113	527.20	157.40	138.10	231.70	105	568.50	181.20	114.20	263.10
4	20	132	765.80	235.40	172.20	358.20	143	798.90	267.20	159.30	372.40
5	20	122	574.60	162.00	148.50	264.10	110	635.20	199.30	125.40	310.50
Total ...	100	627	3364.60	1030.10	806.00	1528.50	607	3391.10	1106.80	668.70	1605.60
Av.	20	125	652.90	206.00	161.20	305.70	121.4	678.20	221.36	133.70	321.10
Three plants to a hill											
1	20	201	984.00	363.10	209.50	411.40	113	628.70	189.80	137.50	301.40
2	20	128	669.80	206.90	148.70	314.20	138	717.80	227.40	151.20	339.20
3	20	137	706.10	219.20	152.80	334.10	110	563.30	158.20	122.70	282.40
4	20	113	603.30	178.40	131.20	293.70	119	678.80	213.50	145.60	319.70
5	20	112	534.90	157.80	120.60	256.50	105	515.10	136.00	119.80	259.30
Total ...	100	691	3498.10	1125.40	762.80	1609.90	585	3103.70	924.90	676.80	1502.00
Av.	20	138	699.50	225.08	152.50	321.90	117	620.70	184.90	135.60	300.40

TABLE 7

Percentage and average yield in capsules, lint and seeds for each treatment

PLOT NO.	DISTANCE OF PLANTING	PLANTS TO A HILL	TOTAL AV. WT. OF BOLLS	CAPSULES		LINT		SEEDS	
				Av. wt.	Per cent	Av. wt.	Per cent	Av. wt.	Per cent
	cm.	*number*	*grams*	*grams*		*grams*		*grams*	
5	75 × 50	1	1118.40	387.00	34.60	246.80	22.06	484.66	43.32
5	75 × 100	1	1029.10	373.50	36.28	211.30	20.52	444.98	43.20
5	100 × 100	1	690.30	210.30	30.46	176.60	25.58	303.40	43.95
5	100 × 110	1	817.20	277.20	33.91	163.40	19.99	376.50	45.45
5	75 × 50	2	882.50	294.80	33.36	184.00	20.82	404.80	45.81
5	75 × 100	2	821.90	266.80	32.46	172.80	21.02	382.40	46.52
5	100 × 100	2	652.90	206.00	30.61	161.20	23.94	305.70	45.43
5	100 × 110	2	678.20	221.46	32.63	133.70	19.71	321.10	47.34
5	75 × 50	3	995.90	316.80	31.81	204.90	20.57	474.20	47.61
5	75 × 100	3	816.40	272.60	33.39	172.60	21.14	371.10	45.45
5	100 × 100	3	699.50	225.08	32.17	152.50	21.80	321.90	46.01
5	100 × 110	3	620.70	184.90	29.78	135.30	21.79	300.40	48.39

TABLE 8

Actual yield in lint in each plot and the computed yield per hectare

PLOT NO.	75 CM. × 50 CM.		75 CM. × 100 CM.		100 CM. × 100 CM.		100 CM. × 110 CM.	
	Weight of lint	Computed yield per Ha.	Weight of lint	Computed yield per Ha.	Weight of lint	Computed yield per Ha.	Weight of lint	Computed yield per Ha.
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
One plant to a hall								
1	0.3106	155.00	0.1957	97.90	0.1476	73.80	0.1521	76.00
2	0.2946	147.30	0.2370	118.50	0.1924	96.20	0.2151	107.60
3	0.2084	104.20	0.1863	93.20	0.1739	87.00	0.1543	77.20
4	0.2222	111.10	0.2946	147.30	0.1832	91.60	0.1619	81.00
5	0.1982	99.10	0.1429	71.50	0.1857	92.10	0.1339	67.00
Total	1.2340	616.70	1.0565	528.40	0.8828	440.70	0.8173	408.80
Av.	0.2468	123.34	0.2113	105.68	0.1766	88.14	0.1635	81.76
Two plants to a hill								
1	0.2363	118.20	0.2034	111.70	0.1577	78.90	0.1481	74.10
2	0.1585	79.30	0.1922	96.10	0.1895	90.80	0.1217	60.90
3	0.1890	94.50	0.1590	78.50	0.1381	69.00	0.1142	57.10
4	0.1704	85.20	0.1764	88.40	0.1722	86.10	0.1593	79.70
5	0.1658	82.90	0.1329	66.50	0.1485	74.30	0.1254	62.70
Total	0.9200	460.10	0.8639	442.20	0.8060	399.10	0.6687	334.50
Av.	0.1850	92.02	0.1728	88.44	0.1612	79.82	0.1337	66.90
Three plants to a hill								
1	0.2634	131.70	0.1563	78.00	0.2095	104.70	0.1375	68.80
2	0.1839	92.00	0.2140	107.00	0.1487	74.20	0.1512	75.00
3	0.2296	114.80	0.1298	64.90	0.1528	76.40	0.1227	61.40
4	0.1913	95.70	0.1917	95.50	0.1312	65.60	0.1456	71.30
5	0.1565	78.30	0.1715	85.30	0.1206	60.30	0.1198	54.70
Total	1.0247	512.50	0.8633	430.70	0.7628	381.20	0.6768	331.20
Av.	0.2049	102.50	0.1727	86.14	0.1526	76.24	0.1354	66.24

TABLE 9

Summary of the effect of distancing and number of plants to a hill on the yield of lint per hectare

DISTANCE OF PLANTING	NUMBER OF PLANTS TO A HILL		
	One plant	Two plants	Three plants
cm.	*kgm.*	*kgm.*	*kgm.*
75 × 50	123.34 ± 7.838	92.02 ± 4.506	102.50 ± 6.222
75 × 100	105.68 ± 8.288	88.44 ± 6.451	86.14 ± 4.858
100 × 100	88.14 ± 2.610	79.82 ± 2.702	76.24 ± 5.059
100 × 110	81.76 ± 4.627	66.90 ± 2.900	66.24 ± 2.503

TABLE 10

Showing differences of effects of treatments on mean yield of lint per hectare

DISTANCE OF PLANTING	DIFFERENCE OF TWO MEANS BETWEEN ONE PLANT AND TWO PLANTS TO A HILL	DEGREE OF DIFFERENCES	DIFFERENCE OF TWO MEANS OF ONE PLANT AND THREE PLANTS TO A HILL	DEGREE OF DIFFERENCES	DIFFERENCE OF TWO MEANS OF TWO PLANTS AND THREE PLANTS TO A HILL	DEGREE OF DIFFERENCES
cm.	*kgm.*		*kgm.*		*kgm.*	
75 × 50	31.24 ± 9.0410	Significant	20.84 ± 10.001	Quite insignificant	10.48 ± 7.6820	Quite insignificant
75 × 100	17.24 ± 10.4970	Very insignificant	19.54 ± 9.605	Quite insignificant	2.39 ± 8.0130	Quite insignificant
100 × 100	8.32 ± 3.7570	Insignificant	11.90 ± 5.692	Insignificant	3.58 ± 5.3760	Very insignificant
100 × 110	14.86 ± 5.4600	Insignificant	15.52 ± 5.260	Significant	0.66 ± 3.8300	Very insignificant

PALAY VS. CORN AS A CONSTITUENT OF RATIONS FOR GROWING AND FATTENING PIGS [1]

NICASIO M. GARCIA

INTRODUCTION

Because of over-supply or through damage by fire, flood or long storage farmers may have rice which they can sell only at a price which means a loss and often they cannot sell at all. To utilize such rice in some way that would bring in some returns would be of benefit to the farmer. Converting this grain into pork is a possibility.

Review of literature

Henry and Morrison (1917) state that since no ill effects from the hulls have been known to follow the feeding of rough rice, it may replace corn in ration of farm animals. On account of the hardness of the kernels it gives better results when ground.

Eleven years later, in their revised edition (1929) these authors make the statement that low grade rough rice is commonly fed to stock. Also, that rough rice may replace corn in stock feeding, being worth about 7 per cent more in feeding value than corn.

According to Dodson (1910) one pound of rice without hulls is worth about as much as one and one-sixth pounds of corn or 16 per cent better feed than corn.

Lindsey, Holland and Billings (1896) claim that rice meal and corn meal have equal feeding value when given with skim milk as feed for weanling pigs.

Henry and Morrison (1917) cited the results of the studies made by Conner on the value of rice as feeding stuff. He found rice meal slightly superior to corn meal when fed with skim milk.

Dalrymple et al (1921) cited the results of the studies made by Jordan, Kidder and Long on the feeding of ground rough rice, etc. to hogs. These authors found in their hog feeding test, that corn meal is slightly better than ground rough rice. They state that post-mortem examination showed that the consumption of large quantities of rice did not prove injurious to the digestive organs.

---

[1] Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture, from the College of Agriculture, No. 444; Experiment Station contribution No. 1007. Prepared in the Department of Animal Husbandry under the direction of Dr. Mariano Mondeñedo.

According to Hughes and Mead (1922) feeding whole dry rough rice with tankage is a practice of doubtful value; but rice by-products in combination with tankage and barley produced good market hogs economically.

Hughes and Thomas (1923) reported that paddy rice and damaged paddy rice, when finely ground, can be successfully fed to fattening swine in dry lot when supplemented with tankage.

Objects, time and place of the present work

The objects of this study were to compare the feeding value of: (*a*) soaked palay, and (*b*) cracked palay with cracked corn for growing pigs and for fattening them for the market.

The experiment was begun on April 24, 1932, and was closed on January 26, 1933, thus covering a period of 277 days. Experiment I was begun April 24, 1932 and was closed November 20, 1932. Experiment II was begun July 1, 1932 and was closed January 26, 1933. The work was conducted in the Department of Animal Husbandry, College of Agriculture.

MATERIALS AND METHODS

Materials

Weanling pigs. Twenty-two Berkjala weanling pigs, 18 barrows and 4 spayed females, were used in the first feeding test, designated as experiment I. The animals were fairly uniform in size and condition. Eighteen Berkjala weanling pigs, 9 barrows and 9 spayed females, were used in the second feeding test, experiment II.

Feeds used. The feeds used and their prices at the time the experiments were conducted were as follows:

Rice bran	₱ 1.10	per	cavan	or	₱.044	per	kgm.
Corn	2.97	"	"	"	.051	"	"
Palay	2.17	"	"	"	.050	"	"
Copra meal	₱32.00	"	ton	"	.032	"	"
Shrimps	2.00	"	cavan	"	.16	"	"

The cost of cracking corn and also cracking palay was ₱0.17 per cavan, which was included in the prices given above.

Showing the chemical analysis of corn and palay [a]

FEED STUFF	MOISTURE	ASH	PROTEIN	CRUDE FIBER	N. F. E.	FAT
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Corn	13.86	1.87	8.80	2.97	69.40	3.10
Palay	13.36	5.85	5.64	9.62	63.90	1.63

[a] Analyzed in the Department of Agricultural Chemistry.

Sweet potato soilage. Camote vines in the form of soilage was given to the pigs at noon at the rate of one per cent of the total live weight taken weekly.

Methods

Allotment of pigs. The pigs used in experiment I were divided into two lots as uniformly as possible as to sex, size, and condition. Lot I received the corn feed mixture as the control lot; lot II received soaked palay mixture.

In experiment II the pigs were divided into three uniform lots of six pigs each. Lot III in this experiment was carried as an additional study to experiment I. Lot III received cracked palay.

Rations used. To approximately meet the varying requirements of the pigs as they grew older the proportion of the feeds used varied as follows:

Rations for the first 70-day period

FEEDS	LOT I	LOT II	LOT III
Palay	0	15 parts	15 parts
Corn	15 parts	0	0
Rice bran	60 "	60 "	60 "
Copra meal	20 "	20 "	20 "
Shrimps	5 "	5 "	5 "
Total	100 parts	100 parts	100 parts

Rations for the second 70-day period

FEEDS	LOT I	LOT II	LOT III
Palay	0	20 parts	20 parts
Corn	20 parts	0	0
Rice bran	60 "	60 "	60 "
Copra meal	17 "	17 "	17 "
Shrimps	3 "	3 "	3 "
Total	100 parts	100 parts	100 parts

Rations for the third 70-day period

FEEDS	LOT I	LOT II	LOT III
Palay	0	25 parts	25 parts
Corn	25 parts	0	0
Rice bran	60 "	60 "	60 "
Copra meal	15 "	15 "	15 "
Total	100 parts	100 parts	100 parts

Ration for lot I was taken as standard in both experiments. It was considered as the control, as it is used for the general herd of the College.

Mineral mixture used. To every 100 kgm. of the ration used, two kgm. of a mixture of equal parts of common salt and corn-cob charcoal were added.

Preparation of rations. The whole palay (rough) was soaked for 24 hours before feeding it to the pigs. The other constituents of the ration were fed unsoaked. The corn fed to pigs in lot I was cracked and the palay given to lot III pigs was also cracked.

Feeding. The pigs were hand fed twice daily, the morning feed being given between 6:00 and 7:00 o'clock and the evening feed, between 4:00 and 5:00 o'clock. The rations were fed in the form of a fairly thick slop, to which water was added at the time of feeding. The animals were given as much feed as they could readily consume. After each feeding the animals from the different lots were driven together into a mixed grass pasture (one-eighth hectare lot).

Weighing. Throughout the course of the test, individual weekly weights were taken. For the initial and final weights, the average of the weights of each pig for three consecutive days at the beginning and closing of each period was taken. The weighing was done from 3:00 to 4:00 o'clock p. m., before the pigs received their evening meal. The pigs were cleaned from mud before weighing.

Care and management. Except for the difference in the rations all the pigs were given the same treatment throughout the course of each of the feeding trials. The animals were allowed to run together between meals in a one-eighth hectare mixed grass pasture. When grass pasture was not available the pigs were kept in a one-sixteenth hectare inclosure bare of vegetation; here they were given camote soilage at the rate of one per cent of the total live weight of the pigs taken weekly. This was the treatment during the first and second 70-day periods in experiment I and in the second 70-day period in experiment II. On hot days, at noon, the pigs were driven to the hog pens for a bath. During heavy rains and storms the animals were kept inside the hog house, particularly for the night. The pigs had no shelter in the pasture other than the shade of acacia trees growing along the fence.

At feeding time the pigs were driven from the pasture to the hog house. The pigs were trained to go into their respective feeding pens. Water was available to the pigs at all times.

Observations

In the two feeding trials conducted, the pigs in all the lots were healthy and very active from the beginning to the close of the tests. No difference in size or condition between the lots of pigs was noted. The only noticeable difference was that the pigs in the corn lots had finer hair coats than those of the palay lots, which were slightly but uniformly more hairy.

Throughout the feeding tests the manure of the pigs on soaked palay lots was found to contain grains of palay undigested. In the pasture where the pigs ranged seeds of palay were found which had started to germinate.

DISCUSSION OF RESULTS

Experiment I

First 70-day period. It may be noted in the table that the pigs in lot I (corn) made slightly better gains than those of lot II (soaked palay). The corn lot made an average daily gain of 0.31 kgm.; palay lot, 0.28 kgm. A statistical study of the gains made, however, from the standpoint of the probable error of the means and coefficient of variability, shows that there was no significant difference. The mean daily gains and the corresponding probable error by lots were: lot I, .31 ± .016; lot II, .28 ± 0.14 kgm. The difference between the mean daily gains together with its probable error, therefore, was .03 ± .021 kgm., which was insignificant.

As to the amount of feed needed to make a given unit of gain, lot I required 3.09 kgm. feed to make a kgm. gain, lot II, 3.43 kgm. The difference was 10 per cent in favor of the corn lot.

Although the consumption of feed was greater in lot II, there was no marked difference between the cost of the gains made in the two lots, because palay cost less than corn. The cost of feed per kgm. gain in lot I was ₱0.15, and in lot II, ₱0.16.

Second 70-day period. In the second period of the test it may be seen in the table that the corn lot led the soaked palay lot. Lot I made an average daily gain of 0.38 kgm. per pig, lot II, 0.33 kgm. Subjecting the difference to statistical study, it was found, as in the first period, to be of no significance. The mean daily gains and the corresponding probable error by lots were: lot I, .38 ± .014 kgm.; lot II, .33 ± .015 kgm. The difference of the mean daily gains was .05 ± .021, which was insignificant.

As to the amount of feed needed to make one kilogram gain in weight, lot I required 3.79 kgm., lot II, 4.39 kgm. Expressing the difference in percentage it was about 14 per cent in favor of corn.

As to the cost of feed per kilogram gain, lot I consumed feed worth ₱0.18; lot II, ₱0.20.

Third 70-day period. The summary table shows that lot I made an average daily gain of 0.30 kgm.; lot II, 0.31 kgm. In this period of the test, lot II made slightly better gain (3 per cent) than lot I.

Lot I required 5.86 kgm. feed to make one kilogram gain in weight, lot II, 5.75 kgm. It may be noted that the soaked palay lot had a tendency to equal that of the corn lot as the period of feeding advanced. It may be noted also that the total amount of feed consumed by lot II was greater than that by lot I.

As to the cost of feed to make one kilogram gain, there was no difference. Both lots required ₱0.25 worth of feed.

The 210-day period. Combining the three 70-day periods, it may be noted (see table) that the rate of gains made daily, the amount of feed required by each lot to make a kilogram gain in weight, and the cost of feed to make a kilogram gain were practically the same. The palay lot, however, remained a little poorer than the corn lot in every respect. The corn lot made an average daily gain of 0.33 kgm. a pig; soaked palay lot, 0.31 kgm. Statistically, the gains showed that there was no significant difference. The mean daily gain and the corresponding probable error by lots were; lot I, .38 ± .013 kgm.; lot II, .31 ± .013 kgm. The difference between the mean daily gains in lot I and lot II, together with its probable error, was .02 ± .019 kgm., which was insignificant.

The amount of feed required by lot I to make a kilogram gain in weight was 4.18 kgm.; lot II, 4.55 kgm. The difference, expressed in percentage, is only 8 per cent in favor of lot I.

To make one kilogram of gain required the consumption of feed worth ₱0.19 in lot I, ₱0.20 in lot II. It is likely that had the pigs in lot II been able to digest all the palay grain the palay ration might have equaled if not exceeded the corn ration. For this reason, a second experiment was conducted in which another lot of pigs was given cracked palay in its ration.

Experiment II

First 70-day period. The table shows that lot III (cracked palay) made the most rapid gain with lot I (corn) second, and lot II (soaked palay) a close third. Lot I made an average daily gain of 0.22 kgm. a pig; lot II, 0.21 kgm.; lot III, 0.23 kgm.

As to the amount of feed needed to make a given unit of gain, lot I required 3.52 kgm. feed to make a kgm. gain in weight, lot II, 3.56 kgm., and lot III, 3.38 kgm.

As to the cost per kgm. gain made by lots, there was no marked difference. The cost of feed to make a kilogram gain in weight in lot I and lot II was ₱0.17 each; lot III, ₱0.16.

Second 70-day period. In the second period of the experiment, it may be noted again, as was the case in the first period, that lot III made the most rapid gain of the three lots (see table). Lot III made an average daily gain in weight of 0.26 kgm. a pig, lot II and lot I, each 0.24 kgm. a pig. Lot III was 8 per cent more efficient than lot I or lot II.

As to the amount of feed required to make a kilogram gain in weight there was practically no difference between lot I and lot II. Lot I required 4.66 kgm. feed; lot II, 4.69 kgm.; and lot III, 4.38 kgm. Lot III was 6 per cent more efficient than lot I and 7 per cent more than lot II. The difference was due apparently to the preparation of the palay which was given in the form of cracked palay which is more easily digested than the whole. The cost of feed per kilogram gain was ₱0.22 each for lot I and lot II, ₱0.20 for lot III.

Third 70-day period. In the last 70-day period of the test, lot I was the most efficient in every respect with lot III, second, and lot II, third. The difference, however, was small. Lot I made an average daily gain of 0.21 kgm.; lot II, 0.16 kgm.; and lot III, 0.19 kgm. The animals in no lot made as good gains as they did in the preceding periods. That the pasture in which they grazed was greatly depleted was probably the cause of this result. Besides, for lack of supply, the pigs received no camote soilage. The age of the pigs may also have affected the result.

Lot I required 6.32 kgm. feed to make a kilogram gain in weight, lot II, 8.41 kgm. and lot III, 6.80 kgm. Lot I was 25 per cent more efficient than lot II and 7 per cent more than lot III. During this period of the test, lot II was the slowest to gain in weight and required more feed to make the gains. Toward the end of the period the corn lot showed a tendency to catch up with the cracked palay lot, but the soaked palay lot remained steadily far behind.

Lot I required feed costing ₱0.28 to make a kilogram gain; lot II, ₱0.36; lot III, ₱0.29.

The three 70-day periods combined. Combining the three 70-day periods as a whole feeding test, it was noted that there was not

much difference in the rate of gains made daily, the amount of feed required by each lot to make a kilogram gain in weight and the cost (see table). Lot I made an average daily gain of 0.22 kgm. a pig; lot II, 0.20 kgm.; lot III, 0.23 kgm. The amount of feed required by lot I to make a kilogram gain in weight was 4.81 kgm.; lot II, 5.24 kgm.; and lot III, 4.73 kgm. Lot III was 2 per cent more efficient than lot I and 10 per cent more than lot II. The cost of feed to make a kilogram gain was ₱0.22 in lot I; ₱0.25 in lot II; and ₱0.22 in lot III.

The difference in the mean daily gains made by the three lots of pigs in the three periods of the test were subjected to statistical treatment; all were found to be insignificant. The fact should be noted, however, that the soaked palay remained less efficient than cracked corn and cracked palay slightly better, which was in agreement with the results reported by Conner (*cited by* Henry and Morrison, 1917).

It is interesting to note further that in the two sets of experiments the pigs in the soaked palay lots were always slightly less efficient in making gains than those in the cracked corn lots, with the exception of the third 70-day period in experiment I when the soaked palay lot gave slightly better results than the cracked corn lot. The cracked palay lot, on the other hand, except in the third 70-day period, gave slightly better results than the cracked corn lot. It appears, therefore, that the feed value of palay is influenced in some degree by the preparation it receives before giving it to pigs. Cracking seems to be better than soaking; soaking does not adequately render all the gains available for thorough digestion.

One of the most interesting results noted and which became more evident as the test progressed was the appearance of the pigs in the three lots. The hair of the pigs in the soaked palay lot was long and rough, while the pigs in the corn lot had coats of fine hair. The pigs fed cracked rice were intermediate.

CONCLUSIONS

1. Basing conclusions on the amount of feed required to make a given unit of gain, the soaked palay ration was about 92 per cent and the cracked palay ration 102 per cent as efficient as cracked corn for growing and fattening pigs. The differences in the mean daily gains were insignificant, that is, corn and palay as constituents of the ration used in this experiment for growing and fattening pigs had the same feeding value.

2. The advantage of palay as a substitute for corn in the feed mixture for growing pigs is dependent upon the relative market prices of these two feeds.

3. Corn in the ration of growing pigs turned out better looking animals than palay. The corn produced pigs with hair relatively shorter and finer than that of the palay fed animals. In other words to grow and fatten animals for show purposes corn is a better feed to use than palay.

LITERATURE CITED

DALRYMPLE ET AL, W. H. 1921. Feeding ground rough rice, etc. to horses, mules, hogs and dairy cattle. Louisiana Sta. Bull. 179 (1921), 8. *Cited in the* U. S. Dept. Agric. Exper. Sta. Rec. 48: 68. 1921.

DODSON, W. R. 1910. The value of rice as feeding stuff. Louisiana Planter, 44 (1910), No. 6, p. 92. *Cited in the* U. S. Dept. Agric. Exper. Sta. Rec. 22: 670.

HENRY, W. A., AND F. B. MORRISON. 1917. Feeds and feeding. 17th ed., x + 691 p. Madison: The Henry-Morrison Company.

HENRY, W. A., AND F. B. MORRISON. 1929. Feeds and feeding. Abridged. 6th ed., viii + 440 p., 114 fig. Milwaukee: C. N. Caspar Company.

HUGHES, W. A., AND —— MEAD. 1922. Rice and rice by-products for fattening swine. California Sta. Rpt. 1922, 56–58. *Cited in the* U. S. Dept. Agric. Exper. Sta. Rec. 48: 571. 1923.

HUGHES, E. H., AND B. H. THOMAS. 1923. Feeding rice and rice by-products to swine. California Sta. Rpt. 1923, 85–88. *Cited in the* U. S. Dept. Agric. Exper. Sta. Rec. 52: 1925.

LINDSEY, J. B., E. B. HOLLAND, AND G. A. BILLINGS. 1896. Rice meal vs. corn meal. Massachusetts Hatch Sta. Rpt. 1896, 126–134. *Cited in the* U. S. Dept. Agric. Exper. Sta. Rec. 9: 1897.

TABLE 1

Summary of results

	Experiment I		Experiment II		
	Lot I	Lot II	Lot I	Lot II	Lot III
First 70-day period					
Average initial weight	14.03 kgm.	14.01 kgm.	9.87 kgm.	9.87 kgm.	9.90 kgm.
Average daily gain per pig	0.31 "	0.28 "	0.22 "	0.21 "	0.23 "
Feed consumed per kgm. gain	3.09 "	3.43 "	3.52 "	3.56 "	3.38 "
Feed cost per kgm. gain	₱0.15	₱0.16	₱0.17	₱0.17	₱0.16
Second 70-day period					
Average initial weight	35.95 kgm.	33.79 kgm.	25.00 kgm.	24.83 kgm.	25.70 kgm.
Average daily gain per pig	0.38 "	0.33 "	0.24 "	0.24 "	0.26 "
Feed consumed per kgm. gain	3.79 "	4.39 "	4.66 "	4.69 "	4.38 "
Feed cost per kgm. gain	₱0.18	₱0.20	₱0.22	₱0.22	₱0.20
Third 70-day period					
Average initial weight	62.91 kgm.	57.02 kgm.	41.79 kgm.	41.73 kgm.	43.80 kgm.
Average daily gain per pig	0.30 "	0.31 "	0.21 "	0.16 "	0.19 "
Feed consumed per kgm. gain	5.86 "	5.75 "	6.32 "	8.41 "	6.80 "
Feed cost per kgm. gain	₱0.25	₱0.25	₱0.28	₱0.36	₱0.29
Combined 210-day period					
Average initial weight	14.03 kgm.	14.01 kgm.	9.87 kgm.	9.87 kgm.	9.90 kgm.
Average daily gain per pig	0.33 "	0.31 "	0.22 "	0.20 "	0.23 "
Feed consumed per kgm. gain	4.18 "	4.55 "	4.81 "	5.24 "	4.73 "
Feed cost per kgm. gain	₱0.19	₱0.20	₱0.22	₱0.25	₱0.22

A STUDY OF THE SALT REQUIREMENTS OF THE YOUNG SUGAR CANE PLANT WITH SPECIAL REFERENCE TO ITS NITROGEN REQUIREMENTS [1]

RAFAEL T. DAVID

WITH EIGHT TEXT FIGURES

Because of the sugar it yields, the sugar cane plant (*Saccharum officinarum* L.) receives considerable attention, especially as to its culture requirements. Numerous field tests have been made and various fertilizers tried. Valuable findings derived therefrom are now put into field practice in the Philippines and in other countries.

However, perusal of available literature on salt requirement of sugar cane shows that no careful studies, employing controlled cultures in artificial media, have been made on this subject in the Islands, and not many in other countries. According to Duggar (1917) water cultures have been employed for more than half a century in the study of plant nutrition with success in bringing out important fundamental facts in connection with the mineral requirements of plants. As in this respect, the sugar cane plant had been rather neglected, it was deemed advisable to undertake the present study.

REVIEW OF LITERATURE

Most of the available literature on sugar cane deals with the effects of fertilizers on this plant. So as to be able to compare the salt requirements of a few plants, such as rice, wheat and soybeans with those of the young sugar cane, this review includes results of three of four solution culture studies of these three plants.

Tottingham (1914) reports among other things, that the young wheat plant grew satisfactorily in a culture solution consisting of 0.0049 molar KNO_3, 0.0156 m. KH_2PO_4, 0.0144 m. $Ca(NO_3)_2$, and 0.0116 m. $MgSO_4$, with a total molecular concentration of 0.0465 gram-molecule (of all the salts) per liter. This solution was later materially simplified by Shive (1915) who employed only three main

[1] Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture, from the College of Agriculture, No. 444; Experiment Station contribution No. 1008. Prepared in the Department of Plant Physiology under the direction of Dr. Rafael B. Espino.

salts and found that the culture solution best for the young wheat plant contains 0.0257 m. KH_2PO_4, 0.0074 m. $Ca(NO_3)_2$, and 0.0214 m. $MgSO_4$, with a total concentration of 0.0545 gram-molecule (of all the salts) per liter of the solution.

The salt requirements of soybeans have been studied also. Wolkoff (1918) reports that the best yield of soybeans was obtained from a culture solution containing 0.0156 m. KH_2PO_4, 0.0036 m. $(NH_4)_2SO_4$, 0.0186 m. $Ca(NO_3)_2$ and 0.0174 m. $MgSO_4$, with a total concentration of 0.0554 gram-molecule (of all the salts) per liter.

Espino (1920) reported that the young rice plants could not be grown successfully in any of Shive 3-salt solutions. The plants always turned chlorotic and were stunted in growth. But, upon the addition of ammonium sulfate, well developed plants were obtained, indicating among other things, that the supply of nitrogen only as nitrate was inadequate to produce well developed young rice plants, and that both nitrate and ammonium were essential for the good growth and development of the young plant. Moreover, the absence of nitrate from the culture medium, even if ammonium was present, always produced plants having leaf injuries, drying of older leaves and of tips of leaves. In later years, Espino and Estioko (1931) in a more critical comparative study obtained similar results. From these studies it was found that the best salt proportion for the young rice plant was 1 part KH_2PO_4, 1 to 1-1/2 parts $(NH_4)_2SO_4$, 1 to 1-1/2 parts $Ca(NO_4)_2$ and 4 to 32 parts $MgSO_4$, with a total concentration of 0.002 gram-molecule (of all the salts) per liter when the parts of $MgSO_4$ were rather low; but, when the parts of $MgSO_4$ were much higher, the total concentration of the culture solutions was slightly higher, 0.00875 gram-molecule (of all the salts) per liter of the solution or mixture.

The only solution culture study on sugar cane was made in Louisiana by Pardo (1930) who reports "that the sugar cane was able to obtain its nitrogen requirements from compounds other than nitrate". He reports further that while his study "failed to give a definite answer as to the effect of nitrate nitrogen assimilation by the sugar cane, it gave definite proofs of this plant's capacity for direct utilization of ammonium compounds as sources of nitrogen". Pardo also reports that the nitrogen content of the sugar cane plant was more in the plants supplied with ammonium than in those supplied with nitrate, indicating, according to him, that the assimilation of nitrogen was greater when the plant was supplied with ammonium compounds than when fed on nitrates or nitrites.

OBJECT, TIME AND PLACE OF THE PRESENT STUDY

The object of the study here reported was to determine the salt requirements of the young sugar cane plant with special reference to nitrogen requirements of the plant and in comparison with those of other plants.

This study was conducted in the laboratory of the Department of Plant Physiology of the College of Agriculture at Los Baños, Laguna. It was begun in April, 1931 and ended in January, 1932. Additional experiments were made from October, 1932 to January, 1933. In view of the fact that the cultures were always under shelter, rainfall and some other climatic factors could not materially influence the plants.

MATERIALS AND METHODS

The plant

The sugar cane plant (*Saccharum officinarum* L.) variety Luzon White, was used in this study. Ordinary sugar cane points of about the same age and diameter obtained from the Agronomy Department of this College were cut shorter, leaving one "eye" or bud to each cutting. The shorter cuttings were first planted in germinating boxes containing sterilized sand. Buds soon began to sprout and when about 10 centimeters in height, young plants two weeks of age of similar vigor and state of development, apparently, were selected. The soil on the roots of these plants was carefully washed away with water and then the young plants were set in culture cork stoppers, one plant to each stopper. To fasten the plant in the hole in each stopper a loose cotton plug was used. Each stopper was then inserted into the mouth of a culture bottle previously filled with tap water. Two days later, the tap water was replaced with culture solutions, 250 cubic centimeters to each bottle. To keep the roots of the plant in darkness, the culture bottles were covered with black paper.

The culture media

The single-salt stock culture solutions. The stock culture solutions used were prepared in the manner described by Espino (1920). The single salts were prepared first and the mixing was done afterwards. The salts used were "Baker analyzed" monopotassium phosphate (KH_2PO_4), ammonium sulfate ($[NH_4]_2SO_4$), calcium nitrate ($Ca[NO_3]_2$) and magnesium sulfate ($MgSO_4$). Each single-salt solution was prepared one-tenth molar concentration. Monocalcium phosphate ($CaHPO_4.2H_2O$) was also used in this study; but owing

to the difficulty in dissolving it in water, this salt was prepared in M/40 concentration. Other salts of Ca were also used in lieu of $Ca(NO_3)_2$ when the plants were deprived of NO_3 nitrogen. The ferric phosphate ($FePO_4$) which was used as the source of iron was prepared as described by Livingston (1919). Distilled water was used as solvent.

The stock culture solution. Three types of nutrient solutions were tested. These solutions were prepared as described by Espino (1920). Each culture medium contained 250 cubic centimeters of the culture solution which was renewed at the end of every three days during the experimental period of thirty days.

The 3-salt type I. Each culture solution under this type contained the three salts, mono-potassium phosphate (KH_2PO_4), calcium nitrate ($Ca[NO_3]_2$) and magnesium sulfate ($MgSO_4$), to which a few drops of ferric phosphate were added. The amounts, proportions and concentrations of the salts contained in the culture solutions tested are recorded under legends of figures 1 and 4.

The 4-salt type A. Each culture solution under this type contained all the salts in the 3-salt type, and a certain amount of ammonium sulfate, ($[NH_4]_2SO_4$). The plants grown in the 4-salt solution were, therefore, supplied with nitrogen both as nitrate and as ammonium. The amounts, proportions and concentrations of the salts contained in the culture media of this type are recorded under legends of figures 2 and 3.

The 4-salt type B. Each culture solution under this type contained all the salts in the 4-salt type A, except that the nitrogen was supplied only as ammonium. There was no nitrate nitrogen in the culture medium. Mono-calcium phosphate ($CaHPO_4.2H_2O$) was substituted for the calcium nitrate. In the additional experiments other salts of Ca were used. The amount, proportion and concentration of the salts contained in the nutrient media of this type are given in the legend of figure 5.

EXPERIMENTS AND RESULTS

Plan of experiment

Five sets of cultures were first made, but additional experiments were run later. A description of the experiments included in the first set follows:

Experiment 1. To determine whether or not young sugar cane plants could be grown successfully in complete culture solutions, two sets of cultures were prepared; one consisted of culture solutions of

the 3-salt type; and the other consisted of solutions of the 4-salt type A. These cultures were simultaneously started on May 5, 1931 and discarded on June 8, 1931. The culture media used were of very high total molecular concentrations, 0.0245 gram-molecule in the case of the 3-salt type, and 0.0384 gram-molecule in the case of the 4-salt type. The results were detrimental to the young plants, as these plants were stunted in growth and had chlorotic leaves. But, an important discovery was made, that unlike wheat, buckwheat and soybeans, the young sugar cane plant can not stand culture solutions of relatively high concentrations.

Experiment 2. To determine if young sugar cane plants can be grown successfully in 3-salt culture solutions of lower concentration,

Fig. 1.—Young sugar cane plants grown in 3-salt culture solutions with a total concentration of 0.002 gram-molecule (of all the salts taken together) per liter. The cultures are arranged in the order of height. The proportion and amounts of the salts used were as follows – $KH_2PO_4:Ca(NO_3)_2:MgSO_4$ – *a*, 1-5-5; *b*, 5-5-1; *c*, 1-9-1; *d*, 3-4-4; *e*, 5-1-5; *f*, 1-1-9; *g*, 9-1-1.

one set of cultures was started on June 18, 1931. The young plants were grown for one month in culture solutions of the 3-salt type. Each solution had a total concentration of 0.002 gram-molecule (of all the salts) per liter. To test the nutritive value of the distilled water used, plants were also grown in bottles containing distilled water only. At the end of the experimental period, the plants were photographed (fig. 1) and afterwards harvested. The original experimental data gathered are shown in table 1[2]

[2] Tables 1 to 8 are on file in the Department of Plant Physiology. The comparative results obtained from the different cultures may be seen in figures 1 to 8 in this paper.

Experiment 3. To determine if young sugar cane plants can be grown successfully in culture solutions of the 4-salt type A, each having a lower total concentration than those tried in experiment 1, a set of cultures was started on June 18, 1931 and the experiment closed on July 18, 1931. The young plants were grown in culture solutions of the 4-salt type A, each having a total concentration of 0.002 gram-molecule (of all the salts) per liter. At the end of the experimental period, the plants were observed for physical abnormalities and other features, and were photographed (fig. 2). Then, the cultures were harvested and the experimental data were gathered and recorded in table 2 (see footnote 2).

Experiment 4. To determine the optimum total molecular concentrations of the culture solutions for the young sugar cane plants, four apparently good culture solutions of the 4-salt type A tested in experiment 3 were selected. Each of these solutions was tried in three different total concentrations; namely, 0.001, 0.002, and 0.004 gram-molecule (of all the salts) per liter. The experiment was started on October 24, 1931 and the plants were harvested one month later. Before harvest was made the cultures were photographed (fig. 3). Then the plants were harvested and experimental data were gathered and recorded in table 3 (see footnote 2).

Experiment 5. To try once more certain culture solutions of the 3-salt type on young sugar cane plants, a set of cultures was started on November 22, 1931. This set consisted of the four best culture solutions of the 3-salt type previously studied in experiment 2. Each culture solution was tried in three different total concentrations, 0.001, 0.002, and 0.004 gram-molecule (of all the salts) per liter. At the end of the experimental period the cultures were photographed (fig. 4), harvested and data gathered. To have a control culture, although one week after the 3-salt solutions had been started, a culture solution of the 4-salt type A was included. When the 3-salt cultures were harvested, the 4-salt solution was likewise harvested. The data obtained from each of the duplicate cultures that were tried were recorded in table 4 (see footnote 2).

Experiment 6. To determine whether or not young sugar cane plants can grow and develop well if not supplied with nitrate in the complete culture solutions. From the preceding experiment, it became quite evident that some culture solutions of the 4-salt type A and some of the 3-salt type were about equally good for young sugar cane plants. These plants seem to do well in complete culture solutions in each of which nitrogen was present only as nitrate or simul-

taneously present as nitrate and ammonium. The question then came up whether or not nitrate was essential at all for the normal growth and development of the young plants. To answer this question, experiments were conducted in which three culture solutions, each in triplicate, of the 4-salt type A that had good results were tried. These solutions were compared with similar culture media of

Fig. 2.—Young sugar cane plants grown in culture solutions of the 4-salt type A, each having a total concentration of 0.002 gram-molecule (of all the salts) per liter. The cultures are arranged in the order of height of the plants. The proportion and amounts of the salts used were as follows -- KH_2PO_4:$(NH_4)_2SO_2$:$Ca(NO_3)_2$:$MgSO_4$ *a*, 5-3-2-2; *b*, 5-1-3-3, *c*, 5-5-1-1; *d*, 7-3-1-1; *e*, 7-1-1-3; *f*, 5-1-1-5; *g*, 5-4-1-2; *h*, 3-1-7-1; *i*, 3-5-1-3; *k*, 3-7-1-1; *l*, 1-5-3-3; *m*, 7-2-1-2; *n*, 3-1-1-7; *o*, 3-3-3-3; *p*, 1-1-5-5; *q*, 1-5-5-1; *r*, 1-1-1-9; *s*, 9-1-1-1: *t*, 1-5-1-5; *u*, 1-9-1-1.

the 4-salt type B, the main difference between them being the substitution of the mono-calcium phosphate ($CaHPO_4.2H_2O$) for the $Ca(NO_3)_2$ in each of the three original culture media of the 4-salt

type A, so that the culture solutions of the 4-salt type B contained nitrogen only as ammonium. The cultures were started at the same time on December 21, 1931 and at the end of thirty days the plants were photographed (fig. 5) and then harvested. The experimental data that were gathered were recorded in table 5 (see footnote 2).

Criteria of results

Height of tops. At the time of harvest, the height of top of the plant from each culture was measured from the basal end of the stem to the tip of the longest leaf.

Dry weight of tops. At the time of harvest, the plants from the different cultures were harvested and separately wrapped with paper. They were then dried to constant weight in an electric oven at about 100°C. The dry weights of tops obtained from the different cultures were determined separately on an analytical balance.

Dry weight of roots. The roots obtained from the different cultures were separately dried to constant weight in an electric oven. Then the samples were separately weighed on an analytical balance.

Dry weight of tops and roots. The dry weight of tops and the dry weight of roots from each culture were added together; the sum constitutes the dry weight of tops and roots.

External appearance of plants. At the end of the culture period of thirty days, the plants in this study were observed for some unusual features or state of development of the plant.

DISCUSSION OF RESULTS

Influence of concentration of culture solution on sugar cane plant

It is generally known that growth and development of plants are influenced not only by the composition but also by the concentration of the culture medium. The sugar cane plant is no exception. As was to be expected, the sugar cane plants died or at best were severely stunted in growth when they were supplied with 3-salt solutions or 4-salt solutions each with a total concentration 0.0245 or 0.0384 gram-molecule (of all the salts), respectively, per liter. Later, however, when the total concentrations of the 4-salt type A culture media were lowered to 0.001, 0.002, and 0.004 gram-molecule, fairly well developed plants were obtained. Of these three lower concentrations, the two lowest, the 0.001 gram-molecule and the 0.002 gram-molecule had cultures that produced higher yields of dry matter than those

obtained from the cultures with a total concentration of 0.004 gram-molecule (of all the salts) per liter (fig. 3 and table 3). Also, the three lower total concentrations tested (0.001, 0.002, and 0.004 gram-molecule) in the 3-salt culture media all produced good plants and in this type of culture solutions, the highest concentration tested, 0.004 gram-molecule, was not markedly different from any of the other total concentrations.

This finding seems to indicate that, as far as concentrations of culture solutions are concerned, the young sugar cane plant is similar to the young rice plant, but is decidedly different from the wheat plant. Espino (1920) tried the three lower concentrations with rice and found 0.002 gram-molecule (of all the salts) per liter

Fig. 3.—Young sugar cane plants grown in selected 4-salt type A culture solutions—in three total concentrations—0.001, 0.002, and 0.004 gram-molecule (of all the salts taken together) per liter. The proportion and amount of the salts used were as follows—KH_2PO_4:$(NH_4)_2SO_4$:$Ca(NO_3)_2$:$MgSO_4$ in any of the three concentrations: *a*, 5-3-2-2; *b*, 5-1-3-3; *c*, 5-5-1-1; *d*, 7-3-1-1.

was the best. Wheat plant, however, appears to require a much higher concentration of the culture medium. Shive (1915) obtained the best development of this plant in a 3-salt solution with a total concentration of 0.0545 gram-molecule (of all the salts) per liter, and Tottingham (1914) found 0.0465 gram-molecule to be the optimum total concentration for this plant when grown in 4-salt culture solutions.

Young sugar cane plants in 3-salt culture solutions

Examination of table 1 and figure 1 revealed that some of the young sugar cane plants grown in the 3-salt culture solutions were

to all appearances, fairly well developed. They were tall and apparently healthy. Their leaves were pale green but not chlorotic. Even the poorest culture in the set produced apparently healthy plants.

Further examination of table 1, showed another interesting result. That all high yields under the criteria of (*a*) height of plant, (*b*) dry weight of top, and (*c*) dry weight of top and root, were obtained from the cultures that contained $Ca(NO_3)_2$ in relatively large amounts. On the other hand, except in dry weight of root, cultures 3A2-1, 3A2-5, and 3A2-7 each supplied with only 1 part of $Ca(NO_3)_2$, had relatively low yields under the other criteria. The data in table 1 also showed that the high as well as the low yields under the criteria employed were obtained from the cultures irrespective of the amount of KH_2PO_4 or the amount of $MgSO_4$ present in the solution. Hence, it may be concluded that the principal limiting factor in the growth and development of the young sugar cane plant in the culture solutions tested was the amount of $Ca(NO_3)_2$ or the amount of NO_2 in the culture medium. Also, it may be concluded that within the limits of this set of cultures, the high or the medium NO_3 supply tested was always good for the plant, and that the lowest amount tested was the least beneficial.

As shown by the data in table 4 and by figure 4, the 3-salt cultures found to have a good growth and development of the young plants in experiment 2 (table 1) again produced healthy plants. These were cultures 3A2-2, 3A2-3, 3A2-4, and 3A2-6. For this reason, it is safe to conclude that NO_3 in complete culture solution was good for the plant.

Considering now the relative influence of the three concentrations of the 3-salt solutions tested upon the growth and development of the plant, the data on hand (table 4 and see fig. 4) which were obtained from the four selected good 3-salt solutions were not so markedly different from one another that it is deemed unnecessary to state that one concentration was always better than the other. In other words, it may probably be safe to say that the three total concentrations of the 3-salt solutions tested were about equally good or equally suitable for the young sugar cane plant. It should, of course, be borne in mind that these three concentrations, 0.001, 0.002, and 0.004 gram-molecule, were very much lower than the total concentration (0.0245 gram-molecule) tested in experiment 1, which concentration proved decidedly harmful to the young plant.

Well developed sugar cane plants in 4-salt type A solutions

Examination of table 2 and figure 2 showed that, on the whole, well developed young sugar cane plants were also obtained from the culture solutions of the 4-salt type A. Some of the cultures, however, produced plants with relatively low yield values under the criteria of results used. The results, therefore, seem to indicate that in the set of cultures tested may be found some salt proportions relatively good for the young sugar cane plants. Thus the need of a careful study of the data on hand was suggested.

The four highest yields under each of the criteria of results (except in number of leaves) were arbitrarily selected. Two cultures, 4A2-13 and 4A2-14, were thus selected. These cultures may be considered as the most promising for the young plant, although

Fig. 4.—Young sugar cane plants grown in selected 3-salt type I culture solutions with total concentration of 0.001, 0.002, and 0.004 gram-molecule (of all the salts taken together) per liter. The amounts and proportion of the salts used were as follows—KH_2PO_4: $Ca(NO_3)_2$:$MgSO_4$ in any of the total concentrations of the 3-salt types: *a*, 1-5-5; *b*, 5-5-1; *c*, 1-9-1; *d*, 3-4-4; *x* contained 5 parts KH_2PO_4, 3 parts $(NH_4)_2SO_4$, 2 parts $Ca(NO_3)_2$ and 2 parts $MgSO_4$.

cultures 4A2-10, 4A2-11, 4A2-17 and 4A2-19, were fairly good too; cultures 4A2-10 and 4A2-11 appeared to be the least beneficial, as these cultures had plants with rather narrow leaves. It may, therefore, be possible to exclude these cultures from the list of what may be considered as well balanced culture media for this plant. Both the remaining cultures (4A2-17 and 4A2-19) also had certain objectionable features. Culture 4A2-17 was selected under the criteria of height of plant and length of roots. The data under these two criteria are subject to much variation or fluctuation. Culture 4A2-19 also had an objectionable feature, the prominent red spots on the leaves of the plants, probably not due to a pathological cause, were symptoms of bad nutrition. A similar condition was

observed by Shive (1915) when he conducted culture experiments with other plants. These two solutions may, therefore, not be considered as really well balanced for the plant.

The two best culture solutions, 4A2-13 and 4A2-14, may now be compared. As shown by the data in table 2, except in the criterion of height of top, culture 4A2-13 was far superior to culture 4A2-14. These two solutions have about the same N-P-K contents. Reference to this question will be taken up more fully later.

To make further comparison of the relative nutritive values of cultures 4A2-13, 4A2-14, 4A2-16 and 4A2-19, additional experiments were made. This time, each of the cultures was tried in

Fig. 5.—Young sugar cane plants grown in culture solutions of 4-salt type A and 4-salt type B with concentration of 0.001 gram-molecule (of all the salts taken together) per liter. The amounts and proportion of the salts used were as follows—KH_2PO_4:$(NH_4)_2SO_4$:$Ca(NO_3)_2$ or $CaHPO_4.2H_2O$:$MgSO_4$: *a*, 5-3-2-2; *b*, 5-1-3-3; *c*, 5-5-1-1.

three concentrations; namely, 0.001, 0.002, and 0.004 gram-molecule (of all the salts) per liter. The results that were obtained (table 3 and see fig. 3) proved once more the nutritive values for the young sugar cane plants of some of the culture solutions of the 4-salt type A, in each of which nitrogen was present both as NH_4 and as NO_3 ions. In total concentration of 0.002 gram-molecule, culture 4A2-13 was again easily the best of the four solutions tested. Unfortunately, the plants in culture 4A2-14 in this total concentration were attacked by a fungus which was probably responsible for the decrease in weight of the plants.

In the lower concentration 0.001 gram-molecule (tables 3 and 5 and see fig. 5) cultures 4A1-14, 4A1-13, and 4A1-16 also produced good plants, with culture 4A1-14 probably slightly the best. The difference, however, was so little that it is best to consider the three as about equally nutritive. Again, in these cultures it may be seen that the 4-salt type A solutions having low total concentration were beneficial to the young sugar cane plant. Therefore, it has been proved beyond a doubt that nitrogen present in both NH_4 and NO_3 ions in complete culture solutions having relatively low total concentrations were beneficial to the young plant.

When the relative nutritive values of the four culture solutions (4A2-13, 4A2-14, 4A2-16, and 4A2-19 in table 3 or cultures *a*, *b*, *c*, and *d* in fig. 3) were compared in term of the three total concentrations, 0.001, 0.002, and 0.004 gram-molecule (of all the salts) per liter, it was found that, probably, except in the length of roots, the yields under the other criteria of results of the cultures in either of the first two lower total concentrations were greater than the yields obtained from the corresponding cultures with a total concentration 0.004 gram-molecule. Therefore, for the young sugar cane plants, the optimum total concentration of the selected 4-salt type A solutions was probably 0.001 or 0.002 gram-molecule (of all the salts) per liter or around these two concentrations.

When the salt proportions and the N-P-K contents of two *good* and three *poor* culture solutions of the 4-salt type A (table 2) were compared, the following data were obtained:

CULTURE DESIGNATION	SALT PROPORTIONS				RATIO N-P-K-	CONDITION OF CULTURE
	KH_2PO_4	$(NH_4)_2SO_4$	$Ca(NO_3)_2$	$MgSO_4$		
4A2–13	5	1	3	3	3–5–7	Good
4A2–14	5	3	2	2	5–5–7	
4A2–1	1	1	1	9	2–1–1	Poor
4A2–9	3	3	3	3	5–3–4	
4A2–20	9	1	1	1	2–9–12	

Culture solution of the 4-salt type B not good for young sugar cane plants

Examination of figure 5 and the data in table 5, showed that the culture solutions of 4-salt type A tested were superior to similar culture media in the 4-salt type B. The 4-salt type A solutions produced well-developed plants while the solutions of the other type produced shorter plants with physical injuries, drying of older leaves and of leaf tips, and the presence of white and brown spots

on many leaves. But, the 4-salt type B had all the essential ions or elements present in the solutions of the 4-salt type A, except the nitrate. In type B, the $Ca(NO_3)_2$ in type A was replaced by $CaHPO_4.2H_2O$; the only source of nitrogen in type B was ammonium sulfate. Thus, it appeared that the failure of the young sugar cane plant to attain normal development in the culture media of the 4-salt type B was due to the absence of nitrate. In this respect, therefore, the sugar cane plant was like its relative, the rice plant. Like rice, the young sugar cane plant can thrive well when supplied, in addition to all the essential elements, with nitrogen in two forms, as ammonium and as nitrate. Espino (1920) and Espino and Estioko (1931) reported on these peculiarities as noted

Fig. 6.—Young sugar cane plants grown in complete culture solutions of the 3-salt type I, in which the nitrogen was supplied to the plants only as nitrate and in a 4-salt type A, both ammoniacal and nitrate forms were supplied, with a total concentration of 0.002 and 0.001 gram-molecule (of all the salts taken together) per liter. The proportions and amounts of the salts used were as follows—KH_2PO_4:$Ca(NO_3)_2$:$MgSO_4$: *a*, 1-1-9; *b*, 1-5-5; *c*, 1-9-1; *d*, 3-4-4; *e*, 5-1-5; *f*, 5-5-1; *g*, 9-1-1. The 4-salt type, *x* contained 5 parts KH_2PO_4, 1 part $(NH_4)_2SO_4$, 3 parts $Ca(NO_3)_2$, 3 parts $MgSO_4$.

in results of their studies of the salt requirements of the young rice plants.

It may be mentioned in passing that cultures 4A1-14, 4A1-13, and 4A1-16 which proved good for the young plant in the earlier experiments were again able to produce well developed plants, as shown in figure 5 and by the data in table 5.

Additional experimental data

In order to have more data on which to base conclusions that would be more reliable, additional cultures were made. These

cultures are here presented under three separate experiments, as follows:

Experiment 7. To determine the comparative nutritive values of 3-salt culture solutions for young sugar cane plants, the cultures ran in experiment 2 were again tried. The new set of cultures was run from October 21 to November 30, 1932, and this time each culture was run in triplicate. A 4-salt type A culture solution (culture 4A2-13 in table 2) was used as control. The experimental data under the criteria of results previously reported are given in table 6, (see footnote 2), and a photograph of the plants at the time of harvest was taken (see fig. 6).

Examination of figure 6 and the data in table 6 revealed once more the fact that under the criteria of results (*a*) height of plants, (*b*) dry weight of top, and (*c*) dry weight of top and root, cultures 3A2-2, 3A2-3, 3A2-4 and 3A2-6 were a little better than the rest of the 3-salt cultures. Each of these good cultures contained relatively more $Ca(NO_3)_2$ than any of the rest of the cultures. This finding, after considering further the salt proportions in table 6, seems to confirm the results in table 1 to the effect that the high as well as the low yields, especially under the criterion of dry weight of the plants, were obtained from cultures irrespective of the amount of KH_2PO_4 or the amount of $MgSO_4$ present in the solution. Thus, it may again be concluded that the principal limiting factor in the growth and development of the young sugar cane plants in the culture solutions tested was the amount of $Ca(NO_3)_2$ or the amount of NO_3 in the culture medium. The four apparently exceptionally good cultures of the 3-salt type had the following salt proportions:

CULTURE DESIGNATION	SALT PROPORTIONS		
	KH_2PO_4	$Ca(NO_3)_2$	$MgSO_4$
3A2–2	1	5	5
3A2–3	1	9	1
3A2–4	3	4	4
3A2–6	5	5	1

Figure 6 and the data in table 6 showed that the control 4-salt type A, culture 4A2-13, produced better developed plants than any of the 3-salt solutions tested. This result seemed to indicate that although NO_3 in well balanced culture media was sufficient to produce good plants, nevertheless the presence of nitrogen both as NO_3 and NH_4 in culture 4A2-13 brought about a better growth and development of the young sugar cane plants. Culture 4A1-14 in figure

4 (data in table 4) is also a 4-salt type A, and although it was started one week later than the 3-salt cultures, at the time of harvest the 4A1-14 culture was almost as good as any of the best solutions of the 3-salt type tested. For this reason, this case was another proof of the apparent nutritive superiority of certain culture solutions (containing, in addition to other essential ions, nitrogen both as NO_3 ion and as NH_4 ion) to any of the culture solutions in which nitrogen was present only as NO_3 ion.

Experiment 8. To determine again the relative nutritive values for young sugar cane plants of 4-salt type A culture solutions, cultures 4A2-10, 4A2-13, 4A2-14, 4A2-17, and 4A2-19, which were selected from table 2 as good yielders in dry weights of the plant,

Fig. 7.—Young sugar cane plants grown in complete culture solutions of the 4-salt type A in which the nitrogen was supplied to the plants both as ammonium and nitrate forms, in two total concentrations 0.001 and 0.002 gram-molecule; and of the 3-salt type I in which the nitrogen was supplied only as nitrate, and of the 4-salt type B, in which the nitrogen was supplied only as ammonium, each with a total concentration of 0.001 gram-molecule (of all the salts taken together) per liter. The proportions and amounts of the salts used were—KH_2PO_4:$(NH_4)_2SO_4$:$Ca(NO_3)_2$:$MgSO_4$—*a*, 5-3-2-2; *b*, 5-1-3-3; *c*, 3-5-1-3; *d*, 7-1-1-3; *e*, 7-3-1-1; *x* cntained 1 part KH_2PO_4, 5 parts $Ca(NO_3)_2$ and 5 parts $MgSO_4$; *y* contained 5 parts KH_2PO_4, 1 part $(NH_4)_2SO_4$, 3 parts $CaHPO_4 . 2H_2O$, and 3 parts $MgSO_4$.

were tried again. These solutions had a total concentration of 0.002 gram-molecule and this time each solution was tried in triplicate. Culture solutions with the same salt proportions but with a total concentration of 0.001 gram-molecule were tried, also. Two control cultures, 3A1-2 and 4B1-13, were included. Both of these control cultures produced fairly well developed plants in previous experiments. The salt proportions, total concentrations and experimental data that were obtained from this set of cultures are recorded in table 7 (see footnote 2) and the plants are shown in figure 7.

The data in table 7 showed, among other results, that in total concentration 0.002 gram-molecule (of all the salts) per liter cultures 4A2-13 and 4A2-14 proved once more to be about equally nutritive for the young plant and were the best of the five solutions of the 4-salt type A tested. As in one of the preceding experiments, these same 4-salt type A solutions when fed to the young sugar cane plants at a much lower total concentration (0.001 gram-molecule) always produced about equally well developed plants and it was found rather hard to appraise accurately the correct relative nutritive values of the solutions in question.

The data in table 7 and figure 7 again conclusively showed that culture 4B1-13, a 4-salt type B solution, and containing, among other essential elements or ions, nitrogen only as NH_4, produced relatively poorly developed plants. The results from this set of cultures seem to suggest once more that the young sugar cane plant prefers the presence of nitrogen as NH_4 and as NO_3 in complete culture solutions having relatively low total molecular concentrations. And, that while the young plant did well in a complete culture solution (table 7) in which nitrogen was present only as NO_3, nitrogen when present in culture medium only as NH_4 proved harmful to the young plants, always producing dried leaves or dried leaf tips (table 7 and fig. 7). More experimental data on this point are presented in experiment 9.

Experiment 9. To determine whether the young sugar cane plant could grow well in complete culture solutions in which nitrogen was present only as NH_4, this experiment was started on November 28, 1932 and consisted of seven quadruplicate cultures. The salts and their combinations or proportions in the different culture solutions tested are recorded in table 8 (see footnote 2). Culture A had nitrogen only as NO_3 from $Ca(NO_3)_2$; culture B had nitrogen both as NH_4 from $(NH_4)_2SO_4$ and as NO_3 from $Ca(NO_3)_2$; and the rest of the cultures received nitrogen only as NH_4. To avoid the use of NO_3, $Ca(NO_3)_2$ was not used in the cultures C, D, E, F, and G, and Ca was supplied to the young sugar cane $Ca_3(PO_4)_2$ plant as $Ca(H_2PO_4)_2.H_2O$, $CaHPO_4$, $2H_2O$, $CaSO_4$, $CaCl_2$ or $Ca_3(PO_4)$

On January 6, 1933, or when the sugar cane plants were forty days old, the cultures were photographed (see fig. 8) and the plants harvested. The data obtained under the criteria of results employed are recorded in table 8. Because of lack of time, this set of cultures was not tried again but it had been repeatedly tried by Espino and Estioko (1931) on young rice plants.

Figure 8 and the data in table 8 showed that the plants in either culture A or B were taller than the plants in any of the other cultures. Moreover, except in length and weight of roots, under the criteria of dry weight of plants and of plant parts, culture A or culture B was, in general, better than any of the cultures C, D, E, F, and G. Therefore, as far as nitrogen supply is concerned, young sugar cane plants seem to grow and develop well in complete culture solutions in each of which nitrogen was present only as NO_3 or both NO_3 and NH_4 were present in the same solution at the same time. In this respect, the young sugar cane plant in one way is not like the young rice plant and in another way it is. The dissimilarity was in the fact that nitrogen as NO_3 in complete culture solutions while good for the young sugar cane plant was found by

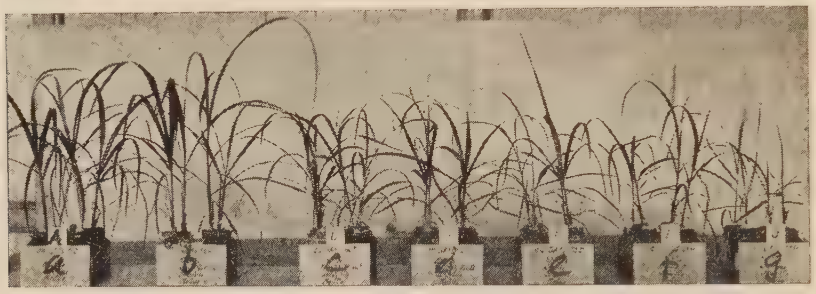


Fig. 8.—Young sugar cane plants grown in complete culture solutions in which nitrate nitrogen, ammoniacal nitrogen or both were present. The amounts and proportions of the salts present in each culture medium were as follows: *a*, 2.5 cc.M/10 KH_2PO_4, 7.5 cc.M/10 $Ca(NO_3)_2$ and 10.0 cc.M/10 $MgSO_4$; *b*, 2.5 cc.M/10 KH_2PO_4, 3.75 cc.M/10 $Ca(H_2PO_4)2.H_2O$, 3.75 cc.M/10 $(NH_4)2SO_4$, and 10.0 cc. M/10 $MgSO_4$; *c*, 2.5 cc.M/10 KH_2PO_4, 375.0 cc.M/1000 $Ca(H_2PO_4)$ $2.H_2O$, 7.5 cc.M/10 $(NH_4)_2SO_4$, and 10.0 cc.M/10 $MgSO_4$; *d*, 2.5 cc.M/10 KH_2PO_4, 375.0 cc.M/1000 $CaHPO_4.2H_2O$, 7.5 cc.M/10 $(NH_4)_2SO_4$, and 10.0 cc.M/10 $MgSO_4$; *e*, 2.5 cc.M/10 KH_2PO_4, 37.5 cc.M/100 $CaSO_4$, 7.5 cc.M/10 $(NH_4)_2SO_4$ and 10.0 cc.M/10 $MgSO_4$; *f*, 2.5 cc.M/10 KH_2PO_4, 3.75 cc.M/10 $CaCl_2$, 7.5 cc. M/10 $(NH_4)_2SO_4$, and 10.0 cc.M/10 $MgSO_4$; *g*, 2.5 cc.M/10 KH_2PO_4, 375.0 cc. M/1000 $Ca_3(PO_4)_2$, 7.5 cc. M/10 $(NH_4)_2SO_4$, and 10.0 cc. M/10 $MgSO_4$.

Espino and Estioko (1931) to be harmful to the young rice plant, always producing stunted growth and chlorotic leaves. The similarity in the nutritive or nitrogen requirements of the two plants, sugar cane and rice, was in the fact that both plants grew and developed well in certain 4-salt type A culture solutions in which nitrogen was present both as NH_4 and as NO_3. Results of Espino and Estioko's researches on rice and the data in table 8 and figure 8 bear this out. These data bear out also the observation that neither the young sugar cane nor the young rice plants

grew well in the complete culture media in which nitrogen was present only as NH_4. As shown by the notes under *external appearance of plants* and probably even by certain plants in figure 8, the NO_3-free solutions always produced on young sugar cane plants older leaves which soon became dry near the tips. A similar physical injury of the leaves was noted by Espino and Estioko on young rice plants that were grown in complete culture solutions in which nitrogen was present only as NO_3.

Salt requirements of sugar cane plants compared with those of other plants

It might be of interest to show the comparative salt requirements of young plants of sugar cane, wheat, rice, and soybeans, as shown by the data obtained from solution culture studies made by other workers. From the results of the studies of these workers the following was compiled:

THE PLANT	PROPORTIONS AND MOLECULAR CONCENTRATIONS OF SALTS					TOTAL CONCENTRATION
	KH_2PO_4	$(NH_4)_2SO_4$	$Ca(NO_3)_2$	$MgSO_4$	KNO_3.	
Sugar cane ..... (David)	0.000417 .000417	0.000167 .000167	0.000208 .000501	0.000208 .000501	— —	0.001 .002
Wheat .... (Tottingham)	.0156	—	.0144	.0166	0.0049	.0465
Rice .... (Espino-Estioko)	.000438	.000656	.000656	.007	—	.00875
Soybeans .... (Wolkoff)	.0156	.0036	.0188	.0174	—	.0554
Wheat .... (Shive)	.0257	—	.0074	.0214	—	.0545
Rice .... (Espino)	.00025	.000375	.000375	.001	—	.002

It may be seen that both the young sugar cane and the young rice plants required culture solutions in relatively very low total molecular concentrations compared with the best concentrations that gave good growth of young wheat and soybean plants. The difference was found to reach even as high as fifty-five times.

As shown by the data given above the young sugar cane plant required relatively low amounts of each of KH_2PO_4, $(NH_4)_2SO_4$, $Ca(NO_3)_2$ and $MgSO_4$. The young rice plant was found to be similar to the sugar cane in this respect, except that the rice required

a relatively high amount of $MgSO_4$. The young wheat and the soybean plants seemed to require quite different salt proportions from those found best for rice and sugar cane. Wheat thrived best even without $(NH_4)_2SO_4$ or without NH_4-ion, requiring salts not constantly of the same proportion, probably depending upon the nature of the salts in the medium. Sugar cane, rice and soybeans required the presence of ammoniacal nitrogen in the culture medium for normal growth and development, and required salt proportions markedly different from those of the wheat, as shown in the following tabulation:

THE PLANT	SALT PROPORTIONS					TOTAL CONCENTRATION IN GRAM-MOLECULE
	KH_2PO_4	$(NH_4)_2SO_4$	$Ca(NO_3)_2$	$MgSO_4$	KNO_3	
Sugar cane .... (David)	2–1/2	1 [a]	1–1/5	1–1/5	—	0.001 or 0.002
Wheat .... (Tottingham)	1	—	9–1/5	7–2/5	3–1/10	0.0465
Rice .... (Espino-Estioko)	1	1–1/2	1–1/2	16	—	0.00875
Soybeans ...... (Wolkoff)	4–3/10	1	5–1/10	4–4/5	—	0.0554
Wheat .... (Shive)	3–1/2	—	1	2–9/10	—	0.0545
Rice .... (Espino	1	1–1/2	1–1/2	4	—	0.002

[a] The lowest molecular concentration in each horizontal column was arbitrarily given the value of 1; the other molecular concentrations in each horizontal column were reduced relatively.

SUMMARY AND CONCLUSION

1. In this study an attempt was made to determine the salt requirements of the young sugar cane plant with special reference to its nitrogen requirements when grown in culture solutions. Whenever possible the salt and nitrogen requirements of this plant were compared with those of wheat, buckwheat and soybeans.

2. Culture solutions having a total concentration exceeding 0.02 gram-molecule (of all the salts) per liter were harmful to the young sugar cane plant. In this respect this plant was unlike wheat, buckwheat or soybeans because these plants grew well in this or even a little higher total concentration.

3. Young sugar cane plants throve well in 4-salt type A solutions and in 3-salt solution having a total concentration of 0.001 or 0.002 gram-molecule (of all the salts) per liter. Total concentration of 0.004 gram-molecule was found also suitable for the young plant in the 3-salt solutions.

4. Good growth and development of the plant was obtained in 4-salt type A solutions in which nitrogen was present as NH_4 and as NO_3 and in complete culture solutions in which nitrogen was present only as NO_3. But, when nitrogen was present only as NH_4, young sugar cane plants with dried leaves and dried leaf tips were produced.

5. Of the 4-salt type A solutions tested, probably the two best solutions had the following salt proportions:

Culture 4A2-13 — $KH_2PO_4:(NH_4)_2SO_4:Ca(NO_3)_2:MgSO_4$ = 5:1:3:3 with a total concentration of 0.002 or 0.001 gram-molecule (of all the salts) per liter.

Culture 4A2-14 — $KH_2PO_4:(NH_4)_2SO_4:Ca(NO_3)_2:MgSO_4$ = 5:3:2:2 with a total concentration of 0.002 or 0.001 gram-molecule (of all the salts) per liter.

6. In the 3-salt solutions tested, relatively well developed young sugar cane plants were obtained from the solutions in which the supply of NO_3 derived from $Ca(NO_3)_2$ was relatively high, but the supply of KH_2PO_4 or of $MgSO_4$ could either be low, medium or high.

LITERATURE CITED

DUGGAR, B. M. 1917. Plant physiology with special reference to plant production. v + 516 p. New York: The Macmillan Company.

ESPINO, R. B. 1920. Some aspects of the salt requirements of young rice plants. The Philippine Jour. Sci. 16: 456–525.

ESPINO, R. B., AND R. P. ESTIOKO. 1931. A critical study of the nutritive values of nitrate nitrogen for young rice plants. The Philippine Agriculturist 20: 27–42.

LIVINGSTON, B. E. 1919. A plan for co-operative research on the salt requirements of representative agricultural plants. Prepared for a Special Committee of the Division of Biology and Agriculture of the National Research Council. p. 1-54.

PARDO, J. H. 1930. Utilization of certain nitrogen compounds by the sugar cane. The Internat. Sugar Jour. 32: 11–19.

SHIVE, JOHN W. 1915. A study of physiological balance in culture media. Physiol. Res. 1: 327–397.

TOTTINGHAM, W. E. 1914. A quantitative chemical and physiological study of nutrient solutions for plant cultures. Physiol. Res. 1: 133–245.

NOTE: THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B. W. I.

On the other side of the globe, in another group of islands is a tropical college of agriculture for which we have a very friendly feeling—indeed, a sisterly affection. As we are thirteen years older than this College—it was opened in 1922—we might say we have an elder sister's affection. This younger sister is the Imperial College of Tropical Agriculture in Trinidad, British West Indies. Because of the warm interest we have in this college, the following personal notes taken from an article in the July issue of *The Journal of the Jamaica Agricultural Society* will be to us like a description of a relative whom we have never seen. Heretofore, the nearest personal touch we have had with this college is its valuable monthly journal, *Tropical Agriculture* which we always eagerly welcome.

Trinidad is an island less than half the size of Jamaica, situated very near the mainland of South America. As one approaches Port-of-Spain by steamship the large harbour dotted with small islands presents a very picturesque appearance, whilst the southern horizon is bounded by the coastline of Venezuela.

There are three main mountain chains, the northern range, which runs along the whole northern side of the island, a central range and a southern range.

The highest point [of the northern range] is slightly over three thousand feet. Some very lovely views are obtainable in this area. The immortelle is grown as shade for the cacao; and, when this is in bloom, the valleys, as seen from above, seem one sheet of flaming red.

Between the northern and central ranges lies the extensive alluvial Caroni plain. On this plain, about seven miles from Port-of-Spain the College is situated.

Set amid park-like grounds, the College presents a beautiful appearance. The buildings consist of a large Main Building which houses the administrative offices, library and lecture rooms; two smaller buildings which contain the chemical and biological departments, and somewhat apart, the dining hall, and Milner hostel. On a separate plot of land are the power house, low temperature research station and experimental sugar factory. Also on the grounds are the residences of several members of the staff. [According to October, 1934 issue of *Tropical Agriculture* the Administrative staff numbers seven; Academic staff, eight; Lecturers, eight; Advising department, (Research officers), eight.]

As nearly half the time of a student in residence is spent in the Milner hostel, it deserves further mention. A two-storied concrete building, it con-

tains accommodation for thirty-two students in individual rooms. Two other buildings bring the total to about forty-five. Each room is about 15 feet by 10 feet, and each has a small balcony of about 10 feet by 5 feet. These rooms serve both as bedrooms and as studies.

Each room is furnished with a bed, desk and chairs, wardrobe and basin with running water. All rooms open on to a central corridor.

Under certain circumstances, students may be granted permission to live outside the College. However, a student who does this is inevitably deprived of much of the friendly camaraderie that is one of the pleasantest aspects of college life.

Meals are served in the dining hall. The dining room is screened, and is furnished with small tables, each seating four people. The meals are excellent. Above the dining room are a reading room and recreation rooms.

On the average, there are between forty and fifty students each year. Of these, nearly a half are usually Colonial Office students who have already obtained a degree or diploma from an English university, and who spend only one year in Trinidad, taking a post-graduate course. Not all are English; some come from Africa, Australia, Ceylon and many other parts of the Empire. The diploma students are usually from the Carribbean area, including some from South American republics.

As regards the actual training, there are three regular courses open to the student who has no previous University training. These are the Certificate, Diploma and Sugar Technology Courses, occupying two, three and four years, respectively.

The Certificate Course is largely practical, with sufficient theoretical work to give the student a scientific grounding. It includes all the essential features of farm management, and is especially suited to the needs of the man who intends to make this his work. He learns how and when to apply the various agricultural operations, largely by having to do them himself. At the same time he gets experience in handling labour. He also learns the principles of pest and disease control in their application to the farm, the chemistry of soil, farm accounting, sanitation, care of live stock and the botany of crops. A short course in Sugar Technology is included.

The first two years of the Diploma Course are the same as for the Certificate. In the third year the student is given the more intensive scientific training that is necessary for an agricultural officer.

In the Sugar Technology Course, the first two years are the same as for the other two courses. During the last two years the student concentrates more on sugar chemistry and engineering.

Besides these standard courses, students interested in special branches of agriculture can have special courses of varying length arranged to suit their particular needs.

The students' day begins with breakfast at 7:30. The first lecture of the day starts at 8:30. There are six one-hour periods each day, from Monday to Friday. There are usually no lectures on Saturday except for third year students. The time each day will be divided between practical work and lectures. If the practical work is in agriculture it will take place on the college farm, which is of about seventy acres. There the first year student will learn to plough, harrow, plant various crops, or perhaps the principles of irrigation and drainage, or the method of harvesting and storing some crop.

The main crops usually grown on the farm include bananas, cane, maize, sorghum, cowpeas, soya beans, yams, sweet potatoes, cotton, tobacco, onions, pigeon peas, ground-nuts, millets, and various green manure and cover crops. Besides this, demonstration plots of less important crops are grown each year. Rice is cultivated in an entirely separate section.

There is no dairy on the farm, only working animals being kept; but the Government Stock farm is very near the College, and students are there made familiar with all the operations of live stock breeding and the care of dairy animals.

Attached to the college there is also a small orchard containing examples of most of the economic fruit trees of the tropics. Demonstrations in the care of citrus trees are given at the Government Experimental Farm. Cocoa, coconut, citrus and sugar estates are visited for further demonstrations.

Other practical work in connection with the courses on chemistry of soils, control of pests and diseases, etc., is performed both in the laboratories and in the field.

Lectures are given on the various subjects by the professors and lecturers. The student takes notes, which he later supplements by recourse to the publications mentioned by the lecturer. These are to be found in the extensive library. These notes then form his text books on the subjects dealt with, no others being found necessary in most cases.

Apart from the six hours per day, there are no restrictions on the way a student spends his time; although he is naturally expected to devote some time to his studies. This privilege is greatly appreciated, and seldom abused.

The rules are as few and as flexible as possible, the students being responsible for the maintenance of order without the necessity for intervention by the College Authorities.

The value of sport as a health measure in the tropics is fully recognized by the Staff, who encourage the students to take part in the organized college games whenever possible. Rugby, soccer, hockey and cricket matches are played against various Trinidad clubs and also against visiting teams. Tennis and swimming are available at the College all the year round.

There is no more noble profession, in my mind, than that of a teacher, with its marvelous opportunities for character building and training the minds of the younger generation. But, in science, research must accompany teaching to prevent him from becoming a mere pedagogue—to keep his own mind from being relegated into that of a mere machine and from losing touch with the advance in his profession. CHARLES L. REESE

Science October, 1934.

The Youth of a Nation are the trustees of Posterity. DISRAELI

ABSTRACTS[1]

The effect of topping and suckering on the yield and quality of tobacco. CEFERINO L. MAGNO. (*Thesis presented for graduation, 1932, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 445; Experiment Station contribution No. 1009*).—The objects of the study were: (*a*) To find out whether topping and suckering will increase the yield and improve the quality of tobacco; and (*b*) to determine the best time for topping and suckering.

The work was conducted in the College of Agriculture Experiment Station from September 1, 1930 to June 30, 1931.

In this study a selected strain of Baker's Sumatra variety was used. The distance of planting was 80 by 75 centimeters. The plants were cultivated and wormed. There were five experimental plots treated differently. Each lot had 1,250 plants. Each treatment was replicated five times. The five plots were treated as follows:

Plot I. Five replications of fifty plants each were not treated and were used as control.

Plot II. Five replications of fifty plants, each with all suckers removed as soon as they appeared.

Plot III. Five replications of fifty plants each with all suckers and heads removed.

Plot IV. Five replications of fifty plants each with only heads removed before any flower opened.

Plot V. Five replications of fifty plants each with all heads removed as soon as five or less flowers opened.

Priming was the method used in harvesting the leaves. The leaves were wilted for about one day and then poled. Bamboo strips were used for poling. The leaves were cured in the Tobacco House in the College of Agriculture. The sand, standard, and top leaves were poled separately. After curing the leaves they were piled in heaps to ferment. These were later on classified according to their quality.

---

[1] Abstracts prepared as part of required theme work in English 3a, College of Agriculture.

The following results were obtained by the author.

The plants in plot V gave the highest average height.

All the treated plants had more leaves than the untreated plants except in plot II. The leaves of the plants in plot III were harvested earlier than the leaves in any other plot. The leaves of the plants from the check plot were harvested the latest.

The leaves produced in plot III were the heaviest. The average yield per hectare of the variety used ranged from 1,413.91 to 2,100.42 kilograms.

The leaves produced in plots I, II, and III could be used for filler, binder or for cigarettes. The leaves produced in plots IV and V qualified for use as wrappers and binders.

From the limited results obtained in this investigation the author made the following few important generalizations.

1. That the lower the tobacco plant was topped, the thicker were the leaves produced at the time of harvest.

2. Low topping and suckering of the plants led to early maturity.

3. The best time for topping the tobacco plants was found to be before the flowers open. A few top leaves should be left.

4. The plants should be topped at the same height in order to obtain a uniform maturity of the leaves.

5. To obtain a heavy yield and to produce a thick leaf, early and low topping of from seven to ten leaves, depending upon the variety used, should be practiced.

—*Abstract by Felipe T. Aala*

Storing corn on a large scale. ARTURO DE LOS REYES. (*Thesis presented for graduation, 1932, with the degree of Bachelor of Agriculture from the College of Agriculture No. 446; Experiment Station contribution No. 1010.*)—This study was conducted in the Seed House of the Department of Agronomy of the College of Agriculture from May 15, 1931 to February 15, 1933. The objects were to find safe methods of storing corn on a large scale and an effective treatment which would check the attack of corn weevils on corn in storage.

The experiment was conducted in two sets. For the first set, three cylinder tanks of the same volume made of galvanized iron were used. All the cylinders were filled to capacity with husked dried corn ears. The first of these cylinders was treated with napthalene balls, the second cylinder was fumigated with carbon bisulphide, and

in the third cylinder, five lighted candles were placed standing on top of the corn ears inside the cylinder. The process used in the third cylinder was called oxygen depletion method. For the second set, three wooden boxes of the same volume were used. These boxes were filled with dried husked corn ears and treated in the same manner as the first set. All the cylinders and boxes were closed as tight as possible. For the control, about 2,000 ears of corn were placed in a large tin tank without cover. After five months the extent of damage caused by weevils was determined by counting the number of destroyed and undestroyed kernels in each ear.

The results in the first set showed that with napthalene balls there was a mean destruction by the insects of 0.27 per cent; with carbon bisulphide fumigation, 4.17 per cent; and with oxygen depletion, 9.80 per cent.

In the second set a comparison of the different treatments was made and results as consistent as in the first set were found.

In both sets napthalene balls treatment proved the most efficient and oxygen depletion method the least efficient.

The result obtained from the oxygen depletion method was compared with the result obtained with the control. The comparison showed that the control was inferior to oxygen depletion method, by a significant difference of 120.11 $\pm$ 0.5742 grains. It follows that the other methods (CS and napthalene balls treatments) were also superior to the control.

The author concluded that the napthalene balls treatment was the most efficient because it gave the lowest percentage of destruction. It was also economical and easy to use. The second was carbon bisulphide, but its inflammable nature and volatility are the two objections to its use. The least efficient was the oxygen depletion method, although, it was the easiest to use.

—*Abstract by Donato G. Dalupang*

KERNELS

"CORN FROM THE SHEAVES OF SCIENCE"

When eating "balut" (incubated egg) do not throw away the embryo chick. It is very nutritious.

A full-grown santol tree was found sterile—not bearing any fruit. The cause of sterility is lack of pollination.

The sterility of *Spondias* was found to be due to the absence of seed in the mature *stone.*

For every 100 kgm. live weight, a native carabao on an average, can consume daily 5.2 kgm. of corn silage; of soilage consisting mostly of sugar cane tops and of a small amount of fresh corn forage, 7 kgm., and can drink 5 liters of water.

For laying hens receiving corn and palay as grain feed, and corn meal and rice bran as mash, copra meal may be used as supplement when fed within the limits of 20 per cent and 30 per cent of the whole feed.

If a hen can produce 120 eggs a year, provided that she is not made to hatch eggs and take care of chicks, she may be expected to produce the following number of eggs each month:

January	11	July	11
February	12	August	7
March	13	September	9
April	11	October	9
May	11	November	8
June	11	December	7

There are 896 chickens in the College of Agriculture, 622 of which are of the Los Baños Cantonese breed. The other breeds are the Philippine, Banaba, Nagoya, J. C. White Leghorn, Barred Plymouth Rock, Rhode Island Red, Black Minorca, Mikawa, Buff Orpington, Silkies, Frizzles and the Jungle fowl.

Pruning or removal of diseased branches and fruits of cacao and then painting the wounds with Bordeaux paste are beneficial to this tree.

CURRENT NOTES

Salt is not a taste. Evidence that this common food ingredient is not tasted but rather felt by some special skin mechanism was presented by Dr. Samuel Renshaw, of the Ohio State University. Thus the four traditional primary tastes—sweet, salt, sour and bitter—are probably now narrowed to three. At a neutral temperature of about body warmth, tastes diminish. Salt, however, does not

follow this rule: it is noticed more in lukewarm foods than in hot dishes. Also it can be noticed on the lips and gums of the mouth where there are no taste organs.

Science, September, 1934.

The constructions of nipa and bamboo are really constructions for the rich rather than the poor because they do not have any element of permanence, and are not convenient for any one who would spend his money wisely.

The Philippine Social Science Review, July, 1934.

Through the ages charcoal has always played a very prominent part in the economic welfare of man. In more recent years it has developed into a considerable industry with many ramifications and by-products.... Waste wood, stumps, branches, etc., could be very profitably converted into this commodity.

Charcoal is undoubtedly the most economical fuel for cooking purposes that one can obtain in Cyprus. Especially is this so in all tropical countries or where the summers are warm and it is undesirable to increase the heat of the kitchen unduly. No other fuel can claim such a virtue. It gives a quick ready heat which can easily be regulated by efficient air control. A good clean hard charcoal made from any of the Cyprus hardwoods such as eucalyptus, plane, ladja, etc., can be readily handled without soiling the hands, and the residue of ash is very small. There is no smoke and, in good charcoal, practically no flame.

In many of the villages in Cyprus there are considerable numbers of fruit trees and in many cases the prunings from such trees are burned as waste material. Very often the large material from the prunings would make a very excellent type of charcoal.

The Cyprus Agricultural Journal, March, 1934.

The highest average production [of sugar] for a three year period in the nineteenth century was 64,000 tons for 1889-1891. It is well to consider fully how this average increase of 36,000 tons (obtained during the last three years) has been achieved.

The increase can be put down almost entirely to the results of agricultural research, viz., better varieties of cane, improved manurial methods and efficient control of pests and disease. The cost of

agricultural research and administration has increased very considerably since the nineties but the value of the crop has increased by more than a quarter of a million pounds.

Agricultural Journal (Barbados, W. I.) April, 1934.

The farmer's show-window is his local and the central exhibitions. It is here that he exhibits the produce he wishes to dispose of. Again, it is a matter for concerted action, since every farmer cannot possibly hold an exhibition on his own.

The exhibition enables the producer to learn by comparing his own products with those of others, with the results that he will concentrate on producing something better every year. In this way the value of his land is enhanced, and this is to the advantage of the country as a whole. The time will come when every farmer who is not an active member of a proper farmers' organization will feel like one who is lost in the desert.

Farming in South Africa, July, 1934.

During the present century the production of coffee in the British Empire has increased from approximately 12,000 to 50,000 tons per annum. In the same period the total world production has grown from roughly 1,000,000 to 2,000,000 tons, so that although the Empire's output has increased by over 300 per cent, its share in the world's production has only risen from about 1.2 to 2.5 per cent. This increase in recent years from 12,000 to 50,000 tons has been almost entirely due to development in British tropical Africa—Kenya, Uganda and Tanganyika—which area now produces some 30,000 tons of coffee.

Tropical Life, August-September, 1934.

The undertaking of a thorough soil survey which would link rainfall data to the water requirements of the plant—by assessing the importance of surface run-off, depth of percolation, fluctuations in level of subsoil water, capillary forces and other pertinent facts—should be as much an essential preliminary to the formulation of a water conservation scheme as the engineer's surveys of land levels and natural sources of supply. Rainfall is without doubt a useful statistic in certain cases, but without the relevant data concerning evaporation, rate of entry into the soil, and sundry other factors it is comparatively useless as an index of the amount of water avail-

able to the plant. The rapid strides which in recent years have been made in the field study of soil conditions in relation to vegetation should be taken advantage of by considering them in conjunction with meteorological records in the formulation of national schemes of conservation.

Tropical Agriculture, October, 1934.

COLLEGE AND ALUMNI NOTES

In 1926 H. H. Prince Dhani then Minister of Education in Siam and his sister, H. H. Princess Sibpan spent a day at the College. In acknowledging a copy of the Silver Jubilee PHILIPPINE AGRICULTURIST, His Highness in a letter to Dean Gonzalez tells that "it has provided me with most interesting and informative reading. Many of your illustrations bring back to me familiar scenes at your College for its work and beautiful site made a deep impression upon me."

Lieutenants Charas Bunbonkas and Charoon Bunnag of the Royal Siamese Navy of the Hydrographic Service of Bangkok, Siam spent a few days of their stay in the Philippines on the Campus with the special object of some study on Agricultural Meteorology. By arrangement with Dean Gonzalez they attended conferences and discussions on: "Weather records in relation to plants", "Crop distribution as related to weather" both under Dr. R. B. Espino, Head, Department of Plant Physiology; "Type of crop production and climate", "Month and season of planting crops and their relation to cultural methods", "Weather and methods of handling harvests", "Acclimatization,—modifying the plant to suit the climate", and "Modifying the weather to suit the crop" all under Dr. N. B. Mendiola, Head of Department of Agronomy; "General relations of insects to weather" and "The use of climatograph and other graphic methods in determination of specific reactions of insects to weather conditions", both under Dr. L. B. Uichanco, Head of Department of Entomology; "Weather as a factor in animal production" under Dean B. M. Gonzalez.

Mr. Luis Osorio of the North Negros Sugar Co. and Mr. E. Roxas of Central Don Pedro at Nasugbu, Batangas were recent Campus visitors. They were interested in cotton culture and the

oil of the different varieties of peanut that the College is growing. They were shown through the College Cassava Starch Factory and the Experiment Station by Dr. N. B. Mendiola.

Mr. Esperidion Presbitero, a land owner of Valladolid, Occidental Negros recently came to the College to make observations on the culture of wheat. Mr. Presbitero is planning to plant wheat at the base of Mount Canlaon. He left a son of one of his tenants on the Campus to observe further the different operations in the culture of wheat as he will be the one to supervise the planting of this crop on Mr. Presbitero's farm.

The ninety-eighth regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Poultry Building, College of Agriculture, on Thursday, November 22, 1934, at 7:30 p. m.

The following papers were read and discussed:

"Studies on the thermal decomposition of coconut oil"
By Dr. F. O. Santos and Mr. J. Banzon.
Paper read by Mr. Banzon.

"Protein supplements in poultry rations: III. The optimum amount of shrimp meal to use as supplement in rations for growing chicks"
By Dr. F. M. Fronda and A. E. Kabigting.
Paper read by Dr. Fronda.

The ninety-ninth regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Poultry Building, College of Agriculture, on Thursday, December 13, 1934, at 7:30 p. m.

The following papers were read and discussed:

"Financial result of ipil-ipil plantation"
By Mr. N. Lalog.

"Experiments on harvesting of sugar cane, *Saccharum officinarum* Linn."
By Dr. V. Calma.

"A study of grading and combining aggregates to obtain maximum voids for concrete work"
By Mr. E. M. Bautista.

Mr. Abelardo Fajardo '32 of the Bureau of Plant Industry recently conferred with Dr. N. B. Mendiola and Mr. V. B. Aragon of the Department of Agronomy about the culture and cost of production of cassava and the cost of producing gaplek in the College.

Mr. Francisco Isidoro '32 and Mr. Leoncio Santiano, a rice and sugar cane planter of Cabiao, Nueva Ecija, visited the Agronomy Department on December 5. Mr. Santiano is especially interested in the cassava starch and toyo manufacture and in cassava growing. He purchased some college products as toyo, cassava starch and brooms and left an order for planting materials of cassava.

In a letter to Dr. N. B. Mendiola, Mr. Manuel Asuncion '34 reports that he is at present connected with the Meram Farm at Laoag, Ilocos Norte as Farm manager. This farm produces vegetables, swine and poultry. Mr. Asuncion asked for information on the fertilization of rice.

Pedro C. Gabertan '34 was a recent department visitor. He is at present connected with the Hacienda J. W. Bayer at Bogus, Caloocan, Rizal as farm manager. The Hacienda, according to Mr. Gabertan, is practicing diversified farming paying special attention to the raising of poultry, tobacco, upland rice and fruit trees. He conferred with Mr. V. B. Aragon about the planting of forage grasses, cover and green manure crops and other farm problems. While here he purchased some planting materials of *Crotalaria* and *Tephrosia* species and Guinea grass.

Experience has shown most of us that more students fail because they do not work than for any other single reason. Investigation has also shown that the average student who satisfies minimum requirements has time to waste. Better mental training, harder study, less superficiality, are what young American needs. DEAN EFFINGER, (Michigan). *What the Colleges are Doing*

"When a man is wrapped up in himself, he makes a rather small package."

GLIMPSES OF HINTERLANDS IN THE SOUTHERN ISLANDS: ZAMBOANGA, JOLO AND CEBU [1]

FROM THE NOTEBOOK OF A SOIL TECHNOLOGIST

In a previous paper [2] were given some notes and observations gathered in the course of a trip with Dr. Edwin Bingham Copeland to Cotabato Province, Mindanao. En route to and from that province, stops were made at various ports, permitting more or less hurried trips inland. While these trips were for the study of the soil conditions and the collection of samples, some of the observations which were of a less technical nature are recorded here.

ZAMBOANGA

We hardly tarried in the town, not even stopping to admire the *waling-waling* nor the profusion of other orchids and flowers decorating even the humblest of homes. Our objective was the plant of the Philippine Cutch Company, located a few kilometers along the coast west of the town. At this factory the tannins from the bark of bacauan (*Rhizophora* sp.) and other trees of the mangrove swamps, not only from Mindanao but also from Palawan and other islands, are being concentrated into cutch, a brownish-black glassy solid. Cutch, being much less bulky than the bark from which it was made, is exported to tanneries in the United States. This factory is one of the world-wide ramifications of the American leather industry, which is searching everywhere for suitable, cheap sources of tanning materials.[3] The bacauan bark, about 80 tons a day, is ground up into fragments a centimeter or less in diameter. The ground bark is moved by conveyors to large wooden tanks where it is mixed with water and allowed to stand for several days, to extract the tannins, which are water soluble. The reddish brown extract is drawn off, clarified by a secret process, and a considerable proportion of the water removed from the solution by treatment in a triple effect evap-

[1] General contribution from the College of Agriculture No. 472.

[2] PENDLETON, ROBERT L. 1935. Glimpses of hinterlands in the Southern Islands: Cotabato. The Philippine Agriculturist 23: 733–746.

[3] Thanks are due to Mr. George Kerr, the manager of the Philippine Cutch Company, for showing us over the plant and discussing freely with us the problems of the commercial tanning processes and sources of the supply of tanning materials.

orator, such as is used in a sugar central. Another piece of sugar mill equipment is the vacuum pan, in which the partially concentrated cutch extract is evaporated to a thick mass. When this stage has been reached the viscous hot cutch is at once run into double jute bags holding 100 lb. each. After filling, these bags remain suspended upon frames some days, or until the cutch cools to air temperature and hardens. The sacks are then closed by hand sewing, and the cutch is ready for shipment.

The supply of suitable bacauan bark in the Philippines is rapidly being consumed; it is estimated that within an economic radius there remains in the Philippines sufficient bark to keep the Zamboanga mill running perhaps three years more. Many Philippine plants, such as the bark of our ipilipil (*Leucaena glauca,* [L.] Benth.) contain sufficiently large quantities of tannins to make practicable the manufacture of cutch. But ipilipil, and many other barks, darken the leather too much, as subsequently 80 per cent at least of the leather is dyed to the desired color, the leather trade demands a light colored tan. Sakat, balakat, kupang and other barks, as exhibited by the Bureau and School of Forestry at Baker Hall on Loyalty Day, 1934, with a high enough concentration in the bark to make extraction profitable, give promise of being commercially satisfactory sources of cutch of the desired quality. But as to these trees, as with camanchile (*Pithecolobium dulce*), there remains the question as to whether or not they can be raised profitably on a plantation basis. If any of these acceptable sources of cutch can be grown successfully on the vast expanses of artificial savannas (cogonals)[4] in the Philippines, it should give an enormous impetus to reforestation, and the product would provide a continuous source of income from what are now deteriorated soils which are only a liability.

Although the continent is nearly 1,800 kilometers distant, Australia's vast expanse of desert seems to make its influence felt in the Zamboanga region as it does in the Celebes and other eastern Netherlands Indies Islands, which lie between Mindanao and Australia. Be that as it may, there is near Zamboanga a remnant of a beautiful grove of *Eucalyptus deglupta* Blume. Botanical collections of this magnificient tree were first made in 1839 by the U. S. Exploring Expedition, more commonly known as the "Wilkes Expedition." This expedition anchored in Caldera Bay, near Zamboanga, and had one of their collecting camps along the Sax River,

---

[4] Cogonals are practically pure stands of the hardy cogon grass (*Imperata cylindrica* [Linn.] Beauv. var. koenigii [Ritz.] Benth. ex Pilgere). The species of the higher mountains is I. *exaltata* Brongn.

a short distance above this eucalyptus grove. Inexcusable extensions of the San Ramon penal farm clearings have almost exterminated this type grove of this rare species of a genus of trees long supposed to be indigenous only in Australia. This needless and wasteful destruction of these magnificent trees, many of which now stand as bare, dead skeletons, can be ascribed only to dendrophobia, the expression of the pioneer's feeling that the tree is the enemy of man and must be cleared away to permit of food production. It is undoubtedly the same dendrophobia which in the Philippines too often "improves" town plazas by first slaughtering the shade trees.

KABASALAN

To the northeast of Zamboanga town, 140 kilometers across Sibuguey Bay, lies the Pathfinder Estate of the Goodyear Rubber Company. Hidden as it is in a low valley behind a fringe of mangrove swamp, from the sea the existence of this oasis of scientific agriculture would never be suspected. But the Moro skipper of the Company's launch knew perfectly the route through these swamps, bringing us to dock where we met our host, Mr. A. H. Muzzall.[5] This Pathfinder Estate, with, in 1933, already over 800 hectares of high yielding clons of Hevea rubber, is being developed according to the findings of the most advanced scientific rubber forestry in the world, that which has been developed in Sumatra. Hence, it is not surprising that the practices employed on this estate put our Philippine efforts along agricultural or plantation forestry very sadly in the shade. From Sumatra plantations of the Goodyear interests have been brought to Kabasalan the budded rubber trees which have supplied the scions of all the special selections or clons which have been used for the budding of the planting material used on the Pathfinder Estate.[6] So it is that many of the best Sumatra clons are being tested under Kabasalan conditions.[7]

While much of the land of the Pathfinder Estate is nearly level, some so low that 15 km. (9.32 miles) of ditches ½ to 1 m. deep have

[5] Mr. Muzzall was long engaged in rubber planting in Sumatra, and in 1925 was a special agent of the United States Department of Commerce Crude Rubber Survey for the Philippine Islands. Mr. Muzzall was a most generous host to our party. Not only was transportation to and from the plantation supplied, as well as the best of Estate accommodations, but he gave freely of his time and information in the discussion of rubber production questions.

[6] Mr. Emilio Macasaet, the superintendent of the plantation, in full charge of the budding work, is a graduate of our College, class of 1928. Mr. Muzzall was high in his praise of the work and ability of Mr. Macasaet.

[7] For a fuller and illustrated description of this plantation, *see* ROBERT L. PENDLETON, 1934. Rubber Forestry. What research might have meant to Agriculture in the Philippines. Sugar news **16**: 7-15.

hilly. While on the flat land the trees are planted on the square, perbeen dug, yet a considerable proportion of the land is more or less haps 6 meters apart, on the sloping land the trees are planted on narrow, 65 cm. (2 ft.) terraces which are laid out exactly on the contour. This means that if one walks along any one row of trees, he will always travel a level path, going out around the hills and into the valleys.

The expression "rubber forestry" was used above advisedly. While Pará rubber (*Hevea braziliensis*) is a typical forest tree, in the past the practice has been to grow it on the plantations as an orchard crop, often clean cultivated. When clean cultivation was used on sloping land, in time serious erosion compelled a modification of the practices, with the introduction of elaborate and expensive terracing or silt pits. With the extremely low prices for rubber which have been prevailing in recent years, only the most economical methods of "cultivation" could be practiced. Dr. H. N. Whitford, sometime Chief of Investigation, Bureau of Forestry, who also headed our Department of Forestry has been a leader in emphasizing that rubber would grow well under controlled forest conditions, and that the "forest" conditions could be maintained at a relatively very low cost, at the same time keeping up the soil fertility. The experience at the Pathfinder Estate confirms this, for aside from the narrow terraces, there is no attempt at cultivation, nor even of thorough clearing of the land prior to planting. *Pueraria* and *Centrosema*, two rapidly growing leguminous vines, do extremely well as cover crops. Where the slopes are not too steep, all the space between the trees is rolled once a month with a heavy wooden roller, about 35 × 100 cm. (14 × 40 in.), drawn by a bullock. This treatment assists the leguminous cover crop vines to dominate the weeds and coarse grasses. The only other attention given to the plantation is to keep the vines cleaned from the trees. Of the two vines, *Pueraria* is considered the better cover crop; but the seed costs about ₱100 per sack, so before planting, one sack of this seed is mixed with 10 sacks of the much cheaper seed of *Centrosema*. Also, as characteristic of "forest" conditions, little attention is paid to the control of diseases of the rubber trees. Not only are the plantations established with the minimum of clearing and digging of the soil, but brown bast and other diseases are looked upon as less serious than formerly. In place of expensive treatment, the present policy is to merely suspend tapping of the affected tree for a time.

At the time of our visit to the Pathfinder Estate, only the very first tree on the plantation was being tapped, so that there was yet no definite data upon the yields to be obtained from any of the special clons. But the same clon in Sumatra had been yielding very well. One regularly gave 800 lb. per acre (900 kgm. per Ha.) a year; one special strain, clon 1152, had on 100 acre stands in Sumatra given yields of 1500 lb. per acre (1670 kgm. per Ha.). It is anticipated that by selection the yield can be raised still further, to as much as 2,000 lb. per acre a year (2,200 kgm. per Ha.). When these figures are compared with those from some of the usual rubber plantations in Mindanao, particularly ungrafted plantations grown from unselected seed, which, even on good soil yield hardly 150 lb. per acre (167 kgm. per Ha.) a year, the contrast is not at all favorable to our agriculture in the Philippines. Unfortunately, the contrast is too typical: most of our crops in the Philippines are of the ordinary sorts, planted in the ordinary way, and except in the case of a portion of the sugar cane crop, if fertilized at all, it is not done on the basis of definite experiments to determine the amounts and kinds of plant foods needed on the particular soils. No wonder that in spite of our good soil and climatic conditions, other parts of the tropics produce so much larger crops, and often at very much smaller cost per unit of produce.

JOLO

A small island, about 20 by 60 km. (12 × 37 miles), entirely volcanic, though with no active craters, is Jolo. The numerous volcanic peaks, some nearly 900 m. (2,900 ft.) high, are a striking feature of the landscape; a few are very steep, while others have long gradual slopes extending from near the summit to the shore. Still other volcanos like beautiful Lake Siit, are very much like our own crater lakes in Laguna Province.

The porous nature of the volcanic ejecta underlying the soil, combined with the absence of streams for surface water, prevents the cultivation of lowland rice except in very restricted localities where the land is low, and there are springs. Because of this porosity of the volcanic materials, in many localities it is impossible to obtain water by digging wells, so that water is transported considerable distances by carabao loaded with short sections of bamboo filled with water. Mrs. Lorillard Spencer, loved and revered by every one on the Island, by developing a water supply and laying for long distances a water pipe, with faucets at convenient places, has thus satisfied a great need of the villagers.

The compact, orderly, settlement at the Harbor surrounded by a Spanish wall now in an advanced stage of decay; precipitous Bud Dahu peak, and deeply set Lake Siit were all reminders of tales of thrilling and often terrible encounters between fearless Moro bands and the constituted authorities. And while we must not allow our attention to be diverted from subjects more directly bearing upon the agriculture of the island, one cannot help realizing the dangers that may result from the continued gradual penetration of the region and obtaining of land by Christians or more properly, by non-Moros.

The main crops of Jolo are upland rice, cassava, sugar cane, abacá, coconuts. While the two latter seem to be limited to the western portion of the island, where the rainfall is reported to be double that in the eastern part, upland rice and cassava are planted very generally. Often cassava is planted in rows nearly 2 meters apart, with upland rice between, and sometimes with sorghum as a third crop. The rice is harvested first, leaving the cassava in the fields for a much longer time. Sugar cane is grown in small plots for chewing or for production of panocha sugar. The process of grinding cane has been described and illustrated elsewhere.[8]

Apparently, long ago the island was very extensively deforested through the extension of caiñgin agriculture, so that now, particularly in the eastern portion, there are vast expanses of cogon. Teak trees, reported to have been introduced, now form considerable bodies of forest, especially in the northern, central and eastern-central parts of the island.

Although the evidence is conflicting, optimists continue to stoutly assert that typhoons never occur in southern Mindanao or in the Sulu Archipelago. The numerous prostrate coconut trees, the tangled wreckage of what were once the largest rubber trees in the Philippines, the sprouting stubs of what had been magnificent bayuno (*Mangifera caesia*) trees, the mountain peaks in places still swept partially clear of all vegetation, and buildings still showing the results of the storm, were ample evidence that the April, 1932 storm was most severe. The long 2 by 4 scantling which we saw sticking into the wall of a house in the port settlement, where it had been driven by the wind, lends weight to the argument that the storm should properly be called a tornado.

Southwest of Jolo, at Indanan, on the road to Parang, is the Willard Straight Agricultural School for Moro boys. Named to

---

[8] ROBERT L. PENDLETON. 1933. Making muscovado sugar in Jolo. Sugar News 14, 599–601.

commemorate the memory of an influential American friend of the Orientals, this private school, supported by American friends of the Moros, impresses one as making a real contribution to the education of this people. There are no frills, and while still suffering severely from the effects of the "typhoon", and still a small school, the influence can be very great of an independent agricultural school, fettered by neither red tape nor bureaucracy. Mr. Leo Mayette, the principal, came to the school from tropical West Africa, and impresses one as eminently fitted for the work. One wishes that the Philippines might be blessed with more such agricultural educational activities.

A Berber, "black as the ace of spades" and dressed in a costume betraying his bringing up in the region of the eastern Mediterranean, saw us taking a soil sample. Asking all about it, he told us he had some peculiar soil upon which he would like an opinion. He promised to meet us on our return at a certain kilometer post, near his house. Sure enough, though it was late when we got back from Lake Siit, there he was, with a biscuit tin of soil, waiting for us. The sample is now in our collection for laboratory study. It seems that Jolo, as a strong center of Mohammedanism, is regularly served by Mohammedan missionaries. This Berber, now a cloth peddler, may originally have come on a religious mission.

CEBU

Long before we reached the harbor, it was clear why the Cebuanos' main food is corn in place of rice; the very shallow soil on the steep slopes, offers little opportunity for the raising of lowland rice. Once ashore and out into the suburbs back of the city, the austerity of the conditions was still better realized. While the porous coral limestone which covers more or less deeply the older and more compact geological formations of much of the island does weather into a heavy black rich soil, the land slopes so steeply that certainly a good deal of the rainfall must run off the surface, while the limestone is so porous that much of the water which soaks into the soil cannot be retained there but percolates to great depths. This means it is often impossible in many places in the uplands to obtain even domestic supplies of water from wells.

In the course of the trip across the island, via Camp 7, to Toledo, we were repeatedly amazed at the steepness of fields cultivated to annual crops. It was, therefore, not difficult to believe that a farmer near Cebu fell *off* his field, breaking a leg.

The thinness of the soil, and the limestone make it impractical to terrace the fields. The black, granular soil even in the dry state naturally very easily works down the slopes, and the corn stalks laid across the slope do not retard erosion very much. Soil erosion is naturally a very serious problem, and in Cebu in numbers of places, there is no longer any soil at all on the limestone. It is fortunate that trees including mangoes seem to thrive on these steep soils, with their roots going deep down into the cracks and crevices of the rocks.

One of our objectives on the trip ashore was to see the classic reforestation project of the Bureau of Forestry. We saw small plots and groves of lumbang, bagilumbang, ipilipil, teak, and other trees, doing very well, but most of the plantings had disappeared. As an experiment to test whether the poor uplands of Cebu Island could be transformed into productive land, about 1916 the Bureau of Forestry was given jurisdiction over a tract of 4095 hectares of hilly and mountainous land in the district between Talisay and Camp 7. The trans-island road passes through the northern portion of this tract. Between 1916 and 1919, with an appropriation of ₱10,000, reforestation was carried on by the Bureau of Forestry personnel. Teak (*Tectona grandis*), molave (*Vitex parviflora*), lumbang (*Aeurities moluccana*), bagilumbang (*Aleuritis trisperma*) and ipil-ipil (*Leucaena glauca*) were used. Soon, wherever policing could be maintained, an excellent stand of trees was obtained, proving that those steep hills with thin soils could produce excellent stands and yields of fuel, timber, and oil seeds. Since there was no provision for adequate policing for the reforested area, the pressure of the population in Cebu was so great that only about three-fourths of the entire project was successfully developed into forest. By 1928 some of the plantings were being managed as permanent forest, supplying fuel wood and other products. It was estimated that for fuel alone the stands were often worth ₱100 per hectare. At this time an economic survey of these reforested lands showed that about 95 per cent of the area should be considered forest lands and should be permanently operated as such, while about 5 per cent of the area should be released for agricultural use. Considering, from their point of view, that the experiment had been a success, since the hill lands had been transformed into productive forest, soon, thereafter, the Bureau of Lands demanded the return of the tract to their jurisdiction. In spite of the findings of the economic survey, the Lands Bureau regained title to all but the forest experiment station near the

summit, at Camp 7, and about 5 per cent of the plantings, which were to be retained as seed plots.[9] Shortly, thereafter, the forested lands were sold to local applicants on the usual installment plan, with a small first payment. As soon as this payment was made the trees were practically all cut off and the produce marketed. It is reported that in many cases the purchasers made no further payments, since as farms the land is almost worthless,—that they abandoned their claims as soon as the fuel and timber had been harvested.

Thus inauspiciously ended the main phase of the first extensive reforestation project in the Philippines. The Bureau of Forestry had demonstrated that economical methods of reforestation would quickly produce profitable forests on the poor eroding soil of the steep hills of Cebu. Then for the personal gain of a few, the forests so developed were almost totally destroyed, leaving for the most part the soils only temporarily better than they had been before—fields capable of producing by dint of much labor only low yields of food crops. Even with a dense population it is extremely short-sighted to exchange profitable and soil protecting forests for bare steep fields from which before long all the soil will have eroded.

There is no question that soil erosion is a serious menace. As has been said, some of the soil on the Cebu hills is already all gone, leaving the limestone exposed. In other places, where there is no limestone, but deeper soils from other sorts of rocks, there is also much erosion. On the west coast below Toledo the Forester pointed out to us near Aloginsan a tract originally a mangrove swamp, classified as communal forest, but due to erosion back in the hills the swamp has been filled, and is now a corn field. However, this land reclamation cannot be considered an unmixed blessing, for undoubtedly a much greater area of soil in the hills was eroded than the area of the swamp filled.

It was not our privilege to see much of the more fertile lowland regions of the island, particularly those devoted to sugar cane, and emphasis has been placed upon the hill soils of the island, for they are the ones which are being destroyed, through cultivation to annual crops. Hence, it is these steep lands which are so greatly in need of conservation. The Bureau of Forestry has demonstrated a method by which it is practicable to supply fuel, timber, oil seeds, and tan bark. Possibilities of combining forestry and agriculture

---

[9] For supplementing the information which we obtained during the visit to the Camp 7 Forest Experiment Station, thanks are due to Forester Placido Dacanay, Chief, Division of Investigation, Bureau of Forestry, who was for some time during its early history in charge of the Cebu Reforestation project.

by having narrow bands or zones of trees planted *on the contour* between wider strips of cultivated land were long ago suggested by the late Dean Baker, but no steps have been taken to prove, even upon an experimental scale, his apparently practical suggestions.

IN CONCLUSION

In these very much disconnected notes, an attempt has been made to record and comment upon things of interest agriculturally. The random reflections will have accomplished their purpose if they stimulate comparisons with, or observations of other regions, or suggest solutions of any of many pressing agricultural questions facing the Islands at this time.

ROBERT L. PENDLETON
Of the Department of Soils

The soil to-day is not just dirt but a universe of life and activity, billions of organisms from the microphages—invisible under the highest powers of the microscope, bacteria, protozoa, microscopic algae, molds, fungi, and a multitude of higher forms, all engaged in breaking down and building up processes that all together make soil.

The factors that favor the fertility-producing and conserving processes are being discovered, as well as those that work in the opposite direction. We are learning to promote the helpful activities and to suppress the harmful activities. The chemists have discovered that out of all these activities there are developed certain colloidal substances that have much to do with what we call soil type. These colloids, with the organic matter which in the past we have lumped under the term humus, have a controlling relation to crop-producing power.

These and other factors are all considered in our soil surveys and classification as a basis for a more highly developed and permanent agriculture and in reclamation procedures.

Then, too, we are beginning to realize the tremendous losses of fertility and waste of soil from slow as well as rapid erosion and we are beginning to take steps to prevent these losses as far as possible. DR. A. F. WOODS, *Director of Scientific Work, U. S. Department of Agriculture.*

MORPHOLOGY OF THE SWEET POTATO, IPOMOEA BATATAS (LINN.) POIR.[1]

José B. Juliano
Of the Department of Plant Physiology

WITH THREE PLATES

Much has been written on the vegetative regeneration (Kupfer, 1907; Beals, 1923; Roque, 1924; Isbell, 1931) and breeding (Wada, 1923; Stout, 1924; Thompson, 1925; Mendiola, 1926) of the sweet potato, an important root crop of the Philippines. The anatomical structure of its root and stem (Groth, 1911; Kamerling, 1914; McCormick, 1916; Artschwager, 1924) has been investigated, and recently Hayward (1932) has completed a thorough study of the seedling anatomy of this root crop. The present paper presents an account of the organography and the development of the gametophytes, fruit and seed.

MATERIAL AND METHODS

The material for this study was collected from sweet potato plants of the Samar Big Yellow variety, grown in the Experimental Garden of the Plant Physiology Department. Flowers in different stages of development were collected at convenient intervals from October to December, 1932, and from Decembr, 1933 to March, 1934. The fruit and seed material was collected on December 22, 1933 when fruit formation was at its height. These were fixed and killed immediately either in the laboratory or in the field in different fixatives, of which chromo-acetic stock and formalin-acetic-alcohol (70 per cent) prepared according to the formulae given by Chamberlain (1932) proved most satisfactory. The material was treated as usual and embedded in paraffin. Sections, six to ten microns thick, were cut, and most of these were stained in Heidenhain's ironalum haematoxylin and counterstained with Aniline orange G dissolved in clove oil.

Controlled self- and close-pollinations in Samar Big Yellow and reciprocal cross-pollinations between Samar Big Yellow and Pirurutung were made in February and March, 1934, results of which

[1] Experiment Station contribution, No. 1016. Received for publication October 13, 1934.

were very gratifying. These two varieties were growing side by side in the Experimental Garden of the Department of Plant Physiology. In all cases pollination was made early in the morning between five and six o'clock. The flowers were bagged the night before their opening, and the stamens were picked up with a pair of clean forceps, and their stigmas dusted with their own microspores for the selfed flower. In the case of the close- and cross-pollinated flowers, their stamens were removed with a pair of clean forceps before they were bagged the night before their opening. The next morning, microspores from flowers of the same plant or from another plant variety, as the case may be, were dusted on their stigmas. During these operations care was taken to clean the instrument with alcohol (95% ethyl alcohol) before attempting to work on another flower.[2]

INVESTIGATION

The flower

Description. The cymose floral cluster of the Samar Big Yellow arises from the axil of the individual leaf, and is borne on a sparsely hairy and purplish peduncle, much shorter though often as long as the petiole. The individual pale purplish flower is held on a short pedicel in a more or less upright or oblique position. Its calyx lobes are five in number, unequal, each more or less linear lanceolate in outline, acuminate, purplish, and provided with a few long hairs on its margins. The corolla is campanulate, 5-lobed, pink-purplish, and its lobes alternate with the sepals. Five stamens of various lengths are attached to the inner basal surface of the corolla, and are much shorter than the style, thus apparently preventing, as much as possible, self-pollination. In the center of the flower is borne a single pistil consisting of (1) a small basal, globose, white ovary, (2) a long, slender, somewhat purplish or whitish style, at the apex of which is (3) a globose, papillate stigma. Surrounding the pistil at its base is a large, cup-shaped disc, which secretes some kind of nectar-like substance. This nectar-like substance appears to attract ants and other insects.

Anthesis. The flowers of Samar Big Yellow and Pirurutung usually show signs of opening at about eleven o'clock in the evening, and a majority are open between four and five o'clock the next morning. Some flowers, however, from both varieties may be open as

---

[2] Thanks are here expressed for the help extended to the writer during the pollination experiments by Mr. Proceso E. Alcala, a Graduate Student Assistant in Plant Physiology.

early as three o'clock in the morning. Generally, by the time the flower has opened, its anthers have dehisced their microspores. The flower remains open during the morning hours, then its corolla closes and withers. Because the anthers are held below the stigma, autogamy or self-pollination is hardly possible unless insects intervene. The time of closing varies with the character of the day; on cool, cloudy days the flower may remain open the whole day, but ordinarily on warm, sunny days it is closed at or about noon, closing usually taking place between nine and ten o'clock. Thompson (1925) observed a similar floral behavior of sweet potato growing in the Virgin Islands.

During the time the flowers are open, the writer has observed several insect visitors. On one sunny day, January 7, 1934, the following insects were found to visit the flowers from eight o'clock in the morning to one o'clock in the afternoon, at which time nearly all of the flowers were closed and wilted. The insects [3] caught are here listed in the order of their abundance: *Apis indica* Fabr. race *nigrocincta* Smith (Hymenoptera), *Phaneroptera furcifera* Stål. (Orthoptera), *Verania discolor* Fabr. (Coleoptera), *Nomia levicauda* Ckll. (Hymenoptera), *Helopeltis* sp. (Hemiptera), a nymph of *Conocephalus* sp. (Orthoptera, a feeder), *Xylocopa* sp. (Hymenoptera), two species of muscoid flies, a single species each of Coleoptera, Chrysomedidae, and Halticinae. Apparently the flower of the sweet potato is favored by visits of numerous insects which are either helpful in pollination or destructive to the microspores or other organs of the plant. That this plant is naturally cross-pollinated is shown by a high percentage of fruit setting in flowers which were artificially cross-pollinated by the writer. Thompson (1925) and Mendiola (1926) also expressed the belief that insects undoubtedly play an important part in the cross-pollination of varieties.

Pollination. By artificially self-pollinating fifty races of sweet potato in Nansei (Loochoo) Islands, Wada (1923) found that two-thirds of these are self-sterile, while some of them produced from one to five fruits per hundred flowers, others, twenty to thirty, and still others, nearly fifty per cent. Stout (1923) suggested that this type of sterility in sweet potato may be due to (1) non-blooming condition, (2) and either the one-sided impotence of intersexualism or (3) more probably, to certain incompatibilities in fertilization. In his observation in the Virgin Islands, Thompson (1925) was led to

[3] Identification of these insects was by Dr. Leopoldo B. Uichanco of the Department of Entomology, to whom the writer is most grateful.

believe that sweet potato is undoubtedly a cross-pollinated plant. Mendiola (1926) was also forced to conclude that the sweet potato is a naturally cross-pollinated plant as experiments so far conducted locally on self-pollination have failed to give positive results.

In order to determine definitely whether the two varieties, Samar Big Yellow and Pirurutung, which were grown side by side in the Experimental Garden of the Department of Plant Physiology, are reciprocally cross-fertile, controlled cross-pollinations were carried out involving six hundred flowers, three hundred from each variety. Of the reciprocal crossings made, ninety-eight (98) per cent of the Samar Big Yellow flowers, and ninety-five (95) per cent of the Pirurutung flowers formed fruits. Controlled pollination studies involving six hundred flowers of Samar Big Yellow showed the following results: (1) forty-eight (48) of the three hundred flowers which were self-pollinated, and (2) sixty-one (61) of the three hundred close-pollinated flowers developed mature fruits. These results undoubtedly demonstrate that these two varieties are reciprocally cross-fertile, and that Samar Big Yellow is both self- and close-fertile to a slight degree. The relative positions of the anthers and the stigma in the flower of Samar Big Yellow do not allow self-pollination to take place very readily, but close- and cross-pollinations are possible because of the presence of numerous insect visitors during its blooming period.

Organography. The development of the floral organs is not strictly *acropetal* as is true in many of our fruit trees, but follows faithfully that reported for the Primulales (Pfeffer, 1872) and *Ipomoea trifida* (Kenyan, 1928). The primordium of the floral cluster appears in the axil of the leaf or as a terminal bud, and this is protected by scales or bracts. The individual floral primordium appears first as a conical, mammillate projection, consisting of undifferentiated tissue (pl. 1, fig. 1) from the axil of a bract or scale on the floral cluster. On this undifferentiated tissue, the sepals (pl. 1, fig. 2) then appear as lateral lobes in a single whorl, and these grow upward and gradually cover the growing primordium (pl. 1, fig. 3). The second series of floral organs which develop on the primordium, are the stamens (pl. 1, fig. 3), which arise as tubular projections within the whorl of sepals and opposite each calyx lobe. These usually grow upward for a while (pl. 1, fig. 4), and then gradually bend a little towards the center of the young floral primerdium (pl. 1, fig. 5). These stamens form very early their club-shaped anthers and their short stubby filaments (pl. 1, fig. 6). Kenyan (1928) observes that the carpels and petals in *Ipomoea trifida*

appear at nearly the same time. In *Ipomoea batatas,* however, the writer has noted that sometimes the petals are formed ahead of the carpels, but usually these two organs appear simultaneously. The petals appear just outside the cycle of the stamens and alternating with them (pl. 1, fig. 4 and 5). The five young petals remain separate for some time (pl. 1, fig. 11), but later fuse at their margins and form a continuous zone or tube, which carries the five stamens at its base on its growth upward. The next organs to develop are the two carpels (pl. 1, fig. 5), which arise at the summit of the growing point of the floral primordium. These two carpels grow upward, and before they form the style and stigma, the primordia of the megasporanges may be seen slightly elevated above the floor of the ovarial cavity (pl. 1, fig. 6). The last floral structure to form is the cup-shaped, circular, yellow disc (pl. 1, fig. 9) at the base of the pistil. The floral organs of *Ipomoea batatas* arise in the following order: sepals, stamens, petals, carpels and disc.

Megasporange and megagametophyte

By the fusion of the two carpels, a two-chambered ovary is formed (pl. 1, fig. 10). Each of the placentas which develop at the margins of the incurving carpels produces a pair of megasporanges, one to each chamber. The primordium of each megasporange or ovule first appears as a small mammillate projection from the placenta at the base of the ovarial chamber (pl. 1, fig. 7). For a short while this primordium grows upward, then it takes a transverse course across the cavity (pl. 1, fig. 8 and 9), and by differential growth is bent downward (pl. 1, fig. 12), and thus becomes anatropous. Transversely, the two megasporanges in each locule diverge so that their nucelli face in opposite directions (pl. 1, fig. 10). The integument and nucellus are well developed by the time the megasporange reaches the opposite wall of the ovarial cavity. The nucellus which is the first to differentiate, projects at an angle of about 45° with a well defined epidermal layer enclosing cells rich in cytoplasm and containing large nuclei. The single integument appears soon and proceeds to grow and enclose the nucellus just before the young megasporange becomes completely anatropous (pl. 1, fig. 12).

The single massive integument of the megasporange behaves in a manner similar to that reported for *Ipomoea trifida* (Kenyan, 1928), in that its growth is continuous. After the nucellus of the young megasporange is completely covered by the single integument, this coat continues to grow far beyond the former, its progressive growth

extending downward. This excessive growth of the integument pushes the nucellus high in the ovarial chamber (pl. 1, fig. 12). By the time the ovarial chamber is completely filled by the two adjacent megasporanges, their nucelli can be located up at their chalazal ends. Consequently, the micropyle undergoes extreme elongation, extending practically more than two-thirds of the length of the whole megasporange. Growth of this massive integument is much more rapid towards the outer wall of the ovary, and this differential growth forces the megasporange to curve inward, thus placing its micropyle in contact with the funiculus.

In *Ipomoea purpurea* Linn. (Kayser, 1893) and *Ipomoea trifida* (Kenyan, 1928) a similar peculiar growth of the integument of the megasporange has been noted. In both species the massive growth of the integument also produces a very long micropylar canal, and that the megasporange contains a very small nucellus which is early abosrbed by the developing embryo sac.

The development of a long, narrow, curved embryo sac is perhaps a characteristic of the family Convolvulaceae. In *Cuscuta gronovii* and *Convoloulus sepium* (MacPherson, 1921) a long curved sac has been found, and it is probable that the small nucellus is absorbed rather early and the embryo sac grows into the slender micropyle, although early stages in the development of the megasporange are wanting. In certain species belonging to other families, similar development of the embryo sac has been observed. Weinstein (1926) reports that the nucellus of *Phaseolus vulgaris* is consumed by the embryo sac, except the capping cells which persist as a hood over the end of the sac until advanced stages in the development of the sac are reached. This sac grows into the micropyle and pushes the cap ahead of it. Lloyd (1902) finds that the embryo sac in Galieae and *Diodia* of the Rubiaceae breaks through the capping cells of the nucellus and passes down the micropyle. The embryo sac protrudes more or less into the micropyle as is true also of *Hemerocallis, Crocus, Gladiolus* and *Romulea* (Ferraris, 1902), *Medicago* and *Torenia asiatica* (Strasburger, 1879). In *Vailantia* according to Lloyd (1902), the mother cell migrates into the micropyle and develops there, while in extreme cases the embryo sac of *Torenia* (Strasburger, 1879) may pass beyond the micropyle and even reach the ovary wall.

The archesporium of the sweet potato usually differentiates on the second layer of nucellar cells below the epidermis (pl. 1, fig. 13). This archesporial cell is easily distinguished from the rest of the

nucellar cells in that it possesses a distinctly large nucleus and dense cytoplasm. According to Schürhoff (1926), a hypodermal archesporium was reported by Peters in 1908 in *Convolvulus* and *Cuscuta*, and this archesporium becomes deep seated owing to the formation of parietal cells. This observation was later confirmed by Asplund in 1920 (Kenyan, 1928) in *Cuscuta lupuliformis*, but Svensson is of the opinion that the archesporial cells observed by Peters are indirectly of epidermal origin (Schürhoff, 1926). Dahlgren (1927) regards Peters' evidence of the presence of parietal tissue as unsatisfactory as certain figures of Peters are cited in which the embryo sac mother cell and spore tetrads are represented in contact with the epidermis of the nucellus. Other cases, which seem to show parietal tissue, are explained by Peters as not having been cut parallel to the long axis of the nucellus. Dahlgren (1927), on the other hand, presents an illustration from his own material of the nucellus of *Cuscuta lupuliformis* with an embryo sac mother cell in synapsis, lying in contact with the epidermis. The same author cites a case of an embryo sac mother cell in contact with the epidermis in *Cuscuta epithymum* and regards the parietal cells in Sympetalae as proved with certainty only in the Plumbaginaceae and Cucurbitaceae. In *Ipomoea trifida*, Kenyan (1928) found that the archesporium is also hypodermal and usually appears at the first and second layers of cells below the epidermis of the nucellus. This archesporial cell functions direct as a megaspore mother cell without forming primary parietal cells similar to that reported here for *Ipomocea batatas*.

The formation of more than one megaspore mother cell in the nucellus of the megasporange of *Ipomoea batatas* is very common (pl. 1, fig. 14). The maximum number that the writer was able to determine is three; usually these megaspore mother cells lie side by side and parallel to the long axis of the nucellus. Generally, only one of these megaspore mother cells gains ascendancy over the others. In *Ipomoea trifida*, Kenyan (1928) observed as many as four megaspore mother cells developing from a single megasporange, the one more deeply embedded in the nucellus usually becomes functional. Kenyan, however, shows in one of her figures a megaspore mother cell separated from the epidermis by a single layer of parietal cells, in another, a mother cell in synapsis lying just under the epidermis which is nearly disintegrated, in which case it is probable that a megaspore mother cell other than the innermost may develop the embryo sac.

The megaspore mother cell then elongates and enlarges (pl. 1, fig. 15). During its enlargement, the scanty nucellar tissue is thus stretched and somewhat distorted, at which time the integument has completely covered it. In *Ipomoea batatas* a linear tetrad of four megaspores is formed (pl. 1, fig. 16), the innermost of which develops the embryo sac.

Megagametophyte. The megagametophyte in sweet potato is normal, and is similar to that reported for *Convolvulus sepium* and *Cuscuta gronovii* (MacPherson, 1921), *Ipomoea trifida* (Kenyan, 1928) and *Convolvulus arvensis* (Schnarf, 1929). As the functional megaspore enlarges, the sister micropylar ones degenerate (pl. 1, fig. 16), as do the nucellar cells, so that the young embryo sac comes to lie directly against the integumentary tissue.

A conventional eight-nucleate megagametophyte is formed by three successive divisions of the nucleus of the functional megaspore (pl. 1, fig. 17; pl. 2, fig. 19, 20, and 21). By the time the first division of the nucleus of the functional megaspore is over, the nucellus is almost gone and the sac is somewhat oblong in shape (pl. 1, fig. 17). Elongation of the original embryo sac may take place very actively then when the second division is over (pl. 2, fig. 18) or perhaps even earlier, and this is accomplished by gradually absorbing first the epidermal layers of the integument and later the hypodermal cells. This absorption of the integumentary tissue proceeds downward, and the sac ultimately conforms in shape with the small curved micropylar canal (pl. 2, fig. 18). During the elongation and development of the embryo sac, it is noted that starch is deposited around it, and also in large quantities in cells found along the inner layers of the integument, a feature perhaps concerned with the nutrition of the young sac.

Differing from *Ipomoea trifida* (Kenyan, 1928) divisions of the nuclei occur at the extreme chalazal end of the sac (pl. 2, fig. 19 and 20), and after the eight nuclei are formed, five of them migrate downward (pl. 2, fig. 21), while the other three remain at the distal end of the sac. The latter nuclei form the antipodals and these are evanescent, usually degenerating before the differentiation of the egg apparatus. The five migrating nuclei form the egg apparatus and the two polar nuclei in the mature megagametophyte (pl. 2, fig. 22). The two polar nuclei which are in contact are uppermost in the group (pl. 2, fig. 21) and apparently are similar in size and shape. Of the other three nuclei below the polars, the largest is the megagamete or egg, while the two others which are unequal, form the synergids.

At maturity of the megagametophyte, the egg apparatus occupies the extreme micropylar end of the sac (pl. 2, fig. 22). The synergids are somewhat pyriform in shape, and contain dense cytoplasm, at the apices of which are located their large, densely stained nuclei. These synergids do not possess any filiform apparatus. The megagamete lies behind and between the synergids, and is much larger, vacuolated, and at its apex is located a small nucleus embedded in a thin peripheral cytoplasm.

The polar nuclei (pl. 2, fig. 22) usually lie close together near the vicinity of the egg apparatus and are rounded in shape, possessing one and occasionally two nucleoli. Their fusion takes place before fertilization.

The antipodals are ephemeral (pl. 2, fig. 21) in nature, and are rarely found to persist long in the sac. They are most always absent at the time the egg apparatus is fully differentiated. It seems that the antipodals of *Ipomoea trifida* (Kenyan, 1928) are more persistent than those in *I. batatas* in that they are present even after the egg apparatus is fully formed.

Microsporange and microspores

The stamen very early forms the anther and the filament (pl. 1, fig. 6). The anther is at first rounded in transverse section, and consists of homogeneous parenchymatous cells surrounded by a distinct epidermis. Very soon the anther becomes four-lobed, and a row of one to three hypodermal cells situated at the second layer of cells below the epidermis under each lobe form the archesporium (pl. 2, fig. 23). The hypodermal layer of cells just below the epidermis form the parietal tissue of three to four layers of cells by a series of periclinal walls, the outermost layer of which functions as the endothecium and the innermost as the tapetum.

The archesporial cells function as the microspore mother cells direct, and their divisions are simultaneous (pl. 2, fig. 25 and 26). Schnarf (1931) speaking on the general morphological characteristics of the Convolvulaceae, says that the pollen mother cells divide simultaneously too and that the mature microspore of *Ipomoea* is binucleate. In *Convolvulus sepium* (Wimmel, 1850) the archesporial cells or sporogenous cells arise at the central portion of the microsporange, and according to his illustration these are formed at about the fifth layer from the epidermis. Schnarf (1929) says that both *Ipomoea tricolor* and *Quamoclit* exhibit simultaneous divisions also in their microspore mother cells.

Just before the microspore mother cell initiates division, the tapetal cells directly surrounding them elongate radially. These tapetal cells which are at first uninucleate, become binucleate prior to the divisions of the microspore mother cells, persisting throughout the time the microspore mother cells are dividing until the tetrads are formed. The outer layers of cells of the parietal tissue are consequently pressed against the epidermis, and are destroyed during the development of the microspores, while the hypodermal layer of parietal tissue persists as the endothecium. The endothecial cells become lignified and their walls considerably thickened, but they lack the characteristic rod-like thickenings so prominent in such cells in other plants.

The microspore mother cell is at first polygonal in shape, and possesses dense cytoplasm and a distinct nucleus (pl. 2, fig. 23). Very soon enlargement sets in and the cytoplasm separates from its wall, either through plasmolysis or otherwise (pl. 2, fig. 24). Its nucleus also enlarges considerably and also its nucleolus. By the time the cytoplasm shrinks from the original wall of the microspore mother cell, it has acquired a distinct special wall of its own and this stains yellow with orange G. This special wall seems to be mucilaginous in character, and encloses the cytoplasm of the microspore mother cell. Soon, the microspore mother cell nucleus divides (pl. 2, fig. 25) and as the four daughter nuclei approach the resting condition, their spindle fibers fail to form distinct separating walls (pl. 2, fig. 26). The whole cytoplasm seems to thin out at the center of the mother cell. Later stages show that the four daughter nuclei become separated from each other (pl. 2, fig. 27), the special mucilaginous wall of the mother cell later disintegrates and finally liberates the young microspores. By what manner these walls enclosing the individual microspores are formed, the writer was not able to determine definitely. In *Ipomoea tricolor* and *Quamoclit* Schnarf (1929) reports that wall formation separating the tetrads occurs as a result of the ingrowth of the walls of the microspore mother cell in a manner similar to that described for *Nicotiana* (Farr, 1915) and *Cucurbita* (Castetter, 1926). In *Lathraea*, Gates (1925) observed that the microspore mother cell wall usually remains in contact throughout the whole process of meiosis until its final dissolution. It does not round off and separate from its sister mother cells more or less completely, a condition similar to that obtaining in sweet potato. Instead, a special microspore mother cell wall, often of great thickness, develops inside the original wall, and this special wall may lie

in contact with or clearly detachable from the mother wall. From this special wall equidistant peripheral points become visible. After the formation of these wedges, active furrowing of the cytoplasm takes place, and the peripheral wedges prolong themselves by passive deposition of wall materials and not by invagination. The prolongation of the peripheral wedges progresses towards the center. In *Ipomoea batatas* the writer is definitely sure that the walls to the microspores are not derived from the spindle fibers.

In *Ipomoea batatas* the original wall of the microspore mother cell remains distinct and does not round off. This wall remains throughout meiosis also and up to the time the tetrads are formed.

The young microspores just after separation from each other may either be lunar, oblong, elongated or pyriform in shape, and each possesses a dense cytoplasm and a distinct nucleus. Each microspore then rounds off, and provides itself with distinct coats, the exine and intine. A prominent characteristic feature of the microspore is the presence of numerous papillae (pl. 2, fig. 28). Long before dehiscence, the microspore possesses a large rounded pollen tube nucleus and a smaller generative nucleus (pl. 2, fig. 28). The mature microspore is white in color, spherical, and bears numerous minute papillae symmetrically arranged on its surface. The nuclei are embedded in a thick peripheral cytoplasm at the center of which is a large vacuole. In *Ipomoea purpurea,* Beer (1911) found the microspore to be binucleate also, and its vegetative nucleus possessing amoeboid feature.

The fruit

Description. The fruit is a dehiscent, almost globose capsule which is purplish in color when young, turning grayish black at maturity. It possesses caducous hairs which are unicellular and hyaline. The mature capsule contains one to two cells, in which are formed one (pl. 2, fig. 29) to two ashy gray seeds. When immature, it is two-celled and in each locule two megasporanges are produced. According to Hayward (1932) a false septum may divide the individual cells so that the fruit may appear to be a four-celled and four-valved capsule with a seed in each locule. This feature was never observed by the writer in either of the varieties referred to above. The pericarp is thin and papyraceous, but firm and brittle.

Development. After fertilization the corolla wilts and is shed, but its calyx remains persistent on the young fruit. The stigma gets dry and usually falls off from the style which dies and darkens downward, the basal portion of which remains persistent and conspicuous-

ly constricted at its attachment to the summit of the ovary. The ovary then enlarges and if fertilization is accomplished, it changes in color from white to pink. Its enlargement is usually asymmetrical at first, that is bulging is more prominent at the region where the developing megasporange is located. On the pericarp are found few to several bristly, long hairs which usually fall off at the maturity of the capsule.

a. Pericarp. At the time the megasporange is still small and prior to fertilization, the ovary wall consists of homogeneous parenchymatous cells delimited by distinct epidermal layers. As the fruit enlarges after fertilization, this homogeneous pericarp then becomes conspicuously differentiated into two distinct regions. On the outer portion, it is covered by a single layer of epidermal cells, the outer walls of which are usually wavy and highly impregnated with cutin (pl. 3, fig. 30, 31, and 32). In these epidermal cells is found the distinct pigment of the pericarp. Enclosed by this outer epidermal layer is a distinct region occupied by large, variously shaped parenchyma, in which are distributed well differentiated large latex vessels. These parenchymatous cells of the outer half of the pericarp tend to become smaller inward. The other half of the pericarp, that is, the inner portion, consists of smaller parenchymatous cells which are elongated parallel to the long axis of the ovary, and are rather rectangular to oblong in shape in transverse section. There are about three or four layers of these cells in the inner half, while the outer half has from five to eight layers of cells.

Lignification of the pericarp takes place only in the inner half of the pericarp. As the fruit matures, the outer portion of the pericarp dries up, only the inner sclerified tissue forming the mechanical covering of the mature capsule. Lignification starts in the region nearest the style and proceeds downward, and from the outermost rectangular cells (pl. 3, fig. 32) inward to the inner epidermis of the pericarp.

b. Septum. The septum (pl. 2, fig. 29; pl. 3, fig. 30) extends across the ovary. Its ground tissue is spongy and is covered by distinct epidermal layers. No lignification takes place in the cells of the septum which becomes membranous and white in color at maturity of the capsule. Three vascular bundles traverse this septum. The false septum reported by Hayward (1932) in the sweet potato capsules he examined is absent in the fruit of Samar Big Yellow.

The seed

Description. The seed is rather small, and measures about three millimeters in its greatest dimension; is somewhat flattened, with one surface angular and the outer roughly convex. It is ashy gray in color and is usually dehisced at maturity of the capsule. Hayward (1932) described the seed, and according to him, its internal structure is similar to those described by Lubbock for other species of *Ipomoea* and *Convolvulus*. The seed coat is rather hard, and is infolded at its inner portion to such an extent that the apical end of the seed is two-chambered. The micropyle is highly invaginated so that a tubular cavity is formed above the hilum. The embryo contains a stubby radicle which occupies the lower portion of the seed formed by the invagination of the micropyle, a pair of cotyledons each occupying the two lateral chambers formed by the intrusion of the septum above the micropyle, and a distinct hypocotyl at the sides of which lie two well-defined auricles. Continued growth of the cotyledons results in the folding of its lobes. Enclosing the embryo is the thin endosperm.

Endosperm. In *Cuscuta gronovii* and *Convolvulus sepium* (MacPherson, 1921), *Cuscuta lupuliformis* and *Pharbitis purpurea* (Schürhoff, 1926), the endosperm is of the nuclear type. In *Ipomoea batatas*, slides of various stages in the development of the seed show that the endosperm is also of the nuclear type. The endosperm later becomes cellular and is not wholly absorbed by the embryo, so that the seed is of the albuminous type.

Embryo. The mature embryo is well described by Hayward (1932). The writer was not so fortunate as to have at his disposal enough material to warrant complete description of its early development.

Nucellus. The nucellus which is not highly developed in the sweet potato is totally absorbed by the embryo sac even before the four nucleate stage of the sac is reached.

Seed coat. The single massive integument of the megasporange, as described above, forms a massive covering around the nucellus of the young megasporange, and by its growth pushes the nucellus way up (pl. 1, fig. 12) forming a long micropylar canal. Further development and elongation of the sac prior to fertilization actually destroys the inner epidermis as well as the hypodermal cells of the integument. After fertilization the embryo sac further reduces the bulk of the integument except at the end and micropylar region of the seed, where infolding and invagination, respectively, take place.

The first indication of the differentiation of the testa is the radial elongation of the hypodermal cells of the massive integument (pl. 3, fig. 34), situated at the second layer below the outer epidermis. It seems that this single layer of cells becomes meristematic and actually divides to form several rows of radially elongated cells (pl. 3, fig. 35) which deform the two outer layers of cells. At maturity of the seed, these radially elongated cells become highly lignified (pl. 3, fig. 37) and form the impermeable coat of the seed.

At the micropylar region, invagination takes place (pl. 3, fig. 30) owing perhaps, to the growth of the obturator which pressed the seed. Moreover, the development of extensive palisaded cells (pl. 3, fig. 36) is also observed. Just abutting the obturator are three or four layers of rectangular, tangentially compressed cells arranged in rows, and these arise by series of periclinal walls from the epidermis of the single integument (pl. 3, fig. 34 and 35). Above the funiculus, the epidermis of the integument becomes enlarged greatly. Below those rectangular cells is a region occupied by several rows of palisaded cells with their long axes perpendicular to the periphery of the seed. The outer cells are much more elongated than those towards the interior. These palisaded cells arise from the first hypodermal cell layer of the integument below the epidermis by periclinal divisions (pl. 3, fig. 34). These palisaded cells together with the rectangular cells above them, form a circular structure at the micropylar region of the seed. In longitudinal section this circular plug to the micropyle is lunar-shaped (pl. 3, fig. 30), because of the fact that the cell layers composing it are more at the central region and become correspondingly fewer towards its periphery.

Below the circular, lunar-shaped structure plugging the micropylar region of the seed, is another region of palisaded cells (pl. 3, fig. 36) which form the continuation of the palisaded cells arising from the second layer of cells below the epidermis of the integument (pl. 3, fig. 35). Below the palisaded cells referred to above are cells which are spongy in nature and most of them are stellate (pl. 3, fig. 38). At maturity of the seed, all the palisaded cells in the micropylar region become greatly thickened and lignified, while the hypodermal cells below the second palisaded layer are only slightly thickened and lignified, and are somewhat distorted in shape.

At maturity of the seed the seed coat is thickest at the angles. The hypodermal cells below the lignified coat become spongy in character and may only be slightly lignified.

Obturator. Around the insertion of the funiculus to the placenta is a mass of parenchymatous tissue (pl. 1, fig. 12; pl. 3, fig. 39), the obturator, and this actually grows after fertilization, forming a cushion-like growth on which the young seed seems to rest. This obturator may actually be so large as to wholly occupy the basal portion of the ovary (pl. 3, fig. 30 and 39) and is composed largely of parenchymatous cells (pl. 3, fig. 36). Pressure against the seed is perhaps partly responsible for the invagination of the seed at its micropylar region.

SUMMARY

The organography, and also the development of the gametophytes, fruit and seed in *Ipomoea batatas* (Linn.) Poir., with special reference to the Samar Big Yellow variety, is herein described. Observation on floral behavior is also given.

The primordium of the floral cluster appears in the axil of the leaf or as a terminal bud. The individual floral primordium develops as a conical, mammillate projection from the axil of a bract or scale on the floral cluster, and its organs appear in sequence as here given: sepals, stamens, petals, carpels and disc.

The ovary is bicarpelled and two-celled. The megasporanges are four, two in each cell. They appear as mammillate projections from the placentas at the base of the ovarial chamber, and become anatropous, each possessing a thin ucellus and a large extensive integument. The single massive integument encloses the nucellus just before the megasporange assumes its anatropous condition, and continues to grow downward beyond the nucellus, pushing the latter high in the ovarial chamber. The micropyle, therefore, undergoes extreme elongation and extends practically more than two-thirds the length of the whole megasporange. Growth of the integument is much more rapid toward the outer wall of the ovary, and this differential growth forces the megasporange to curve inward, thus placing its micropyle in contact with its funiculus where a distinct obturator is developed.

A single-celled archesporium of hypodermal origin is formed in the scanty nucellus, and it functions direct as a megaspore mother cell. Presence of more than one megaspore mother cell is not uncommon.

The megaspore mother cell enlarges and forms a linear tetrad of four megaspores, the innermost of which develops the seven-celled megagametophyte.

In each microsporange, an archesporium, consisting of one to three cells situated at the second layer below the epidermis, is differentiated, and these cells function as the microspore mother cells. Division of the microspore mother cell is simultaneous. The hypodermal cells form the parietal tissue, the outermost layer of which becomes the endothecium, and the innermost layer, the tapetum. The endothecium becomes thick-walled and lignified at maturity of the anther while the tapetal cells elongate considerably and become binucleate.

During meiosis, the cytoplasm of the microspore mother cell separates from its wall and acquires a distinct special mucilaginous wall of its own. Its nucleus divides twice, and at the time the last division is about over, the spindle fibers fail to form distinct walls separating the daughter nuclei. Later, these nuclei become separated from each other, the special mucilaginous wall disintegrating and the young microspores are thus liberated. How the walls separating the tetrads are formed, the writer was unable to determine. The mature microspore before dehiscence is binucleate.

The fruit is a capsule, the pericarp of which differentiates into an outer portion of thin-walled, papyraceous layer and an inner portion of sclerenchymatous cells which form the solid cover to the seed or seeds within the dehiscent capsule. Only one septum is present in the ovary, and this becomes papyraceous at maturity with only three vascular bundles traversing it.

A macroscopical description of the albuminous seed is given. Its endosperm is of the nuclear type. The coat of the mature seed differentiates on the second layer of cells below the epidermis of the massive integument of the megasporange. These cells divide and elongate radially, forming the mature, lignified, impervious coat to the seed. The integumental cells below the seed coat are not wholly destroyed by the endosperm and these cells become spongy and slightly lignified. At the micropylar portion of the mature seed, there is an extensive formation of palisaded cells arising from the two hypodermal layers of the massive integument, all of which become thick-walled and lignified. Those palisaded cells arising from the first hypodermal layer of the integument together with those derived from the epidermis form the rounded structure plugging the micropylar region of the seed.

Results of hand pollinations in this study show that Pirurutung and Samar Big Yellow are reciprocally cross-fertile, and that Samar Big Yellow is both self- and close-fertile to a slight degree.

LITERATURE CITED

ARTSCHWAGER, F. 1924. The anatomy of the sweet potato, with notes on internal breakdown. Jour. Agric. Res. 27: 157–166. *Pl. 1–4; fig. 1–6.*

BEALS, C. M. 1923. An histological study of the regenerative phenomena in plant. Ann. Missouri Bot. Garden 10: 369–384.

BEER, R. 1911. Studies in spore development. Ann. Bot. 25: 199–214.

CASTETTER, E. F. 1926. Cytological studies in the Cucurbitaceae. I. Microsporogenesis in *Cucurbita maxima.* Amer. Jour. Bot. 13: 1–10. *Pl. 1–2.*

CHAMBERLAIN, C. J. 1932. Methods in plant histology. xiv + 416 p., 140 fig. Chicago: The University of Chicago Press.

DAHLGREEN, K. V. D. 1927. Die Morphologie des Nuzellus mit besonderer Berücksichtigung der dechzellosen Typen. Jahrb. wiss. Bot. 67: 347–462. *Pl. 1–32.*

FARR., C. H. 1916. Cytokinesis of the pollen-mother cells of certain dicotyledons. Mem. New York Bot. Garden 6: 253–317. *Pl. 27–29.*

FERRARIS, T. 1902. Richerche embriologiche sulle Iridaceae. I. Embriologie del g. *Romulea Marrati.* Ann. R. Istit. Bot. Roma 9: 221–241. *Pl. 6–7. Cited* by Hayward.

GATES, R. 1925. Pollen tetrad wall formation in *Lathraea.* La Cellule 35: 49–59. *Pl. 1.*

GROTH, B. H. A. 1911. The sweet potato. Contrib. Bot. Lab. Univ. Pennsylvania 4: 1–104. *Cited* by Hayward.

HAYWARD, H. E. 1932. Seedling anatomy of *Ipomoea batatas.* Bot. Gaz. 93: 400–420. *Pl. 6–7; fig. 1–12.*

ISBELL, C. L. 1931. Regeneration in leaf cuttings of *Ipomoea batatas.* Bot. Gaz. 91: 411–425. *Fig. 1–19.*

KAMERLING, Z. 1914. Sind die Knollen von *Batatas edulis* Choisy Wurzeln oder Stengel? Der. d. Deutsch. bot. Gessel. 32: 352–360.

KAYSER, G. 1893. Beiträge zur Kenntniss der Entwicklungsgeschichte der Samen mit besonderer Berücksichtigung des histogenetischen Aufbaus der Samenschalen. Jahrb. wiss. Bot. 25: 79–148. *Pl. 4–7.*

KENYAN, F. M. G. 1928. A morphological and cytological study of *Ipomoea trifida.* Bull. Torrey Bot. Club 55: 499–512. *Pl. 14; fig. 1–3.*

KUPFER, E. 1907. Studies in plant regeneration. Mem. Torrey Bot. Club 12: 195–241. *Fig. 1–13.*

LLOYD, F. E. 1902. Comparative embryology of the Rubiaceae-II. Mem. Torrey Bot. Club 8: 27–112. *Pl. 5–15.*

MACPHERSON, G. E. 1921. Comparison of development in dodder and morning glory. Bot. Gaz. 71: 392–398. *Pl. 25–27.*

MCCORMICK, F. A. 1916. Notes on the anatomy of the young tuber of *Ipomoea batatas* Lam. Bot. Gaz. 61: 388–398. *Fig. 1–8.*

MENDIOLA, N. B. 1926. A manual of plant breeding for the tropics, xxviii + 365p., 56 fig. Univ. Philippines, Manila: Bureau of Printing.

PFEFFER, W. 1872. Zur Blütenentwicklung der Primulaceen und Ampelideen. Jahrb. wiss. Bot. 8: 194–215. *Pl. 19–22.*

ROQUE, D. O. 1924. The growth and yield of sweet potato started from different cuttings. The Philippine Agriculturist 13: 143.

SCHNARF, K. 1929. Embryologie der Angiospermen. xxi + 673 p., 69 illus. Berlin: Verlag von Gebrüden Bertraeger.

SCHNARF, K. 1931. Vergleichende Embryologie der Angiospermen. vii + 354 p., 508 fig. Berlin: Verlag von Gebrüder Borntraeger.

SCHÜRHOFF, P. N. 1926. Die Zytologie der Blütenpflanzen. xi + 792 p., 282 fig. Stuttgart: Verlag von Ferdinand Enke.

STOUT, A. B. 1924. The flowers and seed of sweet potato. Jour. New York Bot. Gard. 25: 153–168. *Pl. 1; fig. 1–3. Abstract in* U. S. Dept. Agric. Exper. Sta. Rec. 53: 838. 1925.

STRASBURGER, E. 1879. Die Angiospermen und die Gymnospermen. viii + 173 p., 22 pl. Jena: Verlag von Gustav Fischer.

THOMPSON, J. B. 1925. Production of sweet-potato seedlings at the Virgin Islands Experiment Station. U. S. Dept. Agric. Virgin Islands Agric. Exper. Sta. Bull. 5: 1–13. *Pl. 1–3; fig. 1–2.*

WADA, U. 1923. Experiments on the breeding and heredity of sweet potato (trans. title). Japan. Jour. Genetics 2: 137–144. *Abstract in* U. S. Dept. Agric. Exper. Sta. Rec. 53: 831. 1925.

WEINSTEIN, A. I. 1926. Cytological studies of *Phaseolus vulgaris.* Amer. Jour. Bot. 13: 248–263. *Pl. 16–19; fig. 1.*

WIMMEL, T. 1850. Zur Entwicklungsgeschichte des Pollens. Bot. Ztg. 8: 225–235, 241–248, 289–294, 313–320. *Fig. 1–112.*

EXPLANATION OF PLATES

Parts of the flower, fruit and seed are designated as follows: (*an*) antipodals, (*br*) bracts, (*c*) carpels, (*d*) disc, (*ep*) epidermis, (*es*) embryo sac, (*ex*) exine, (*f*) funiculus, (*gn*) generative nucleus, (*in*) integument, (*int*) intine, (*l*) locule, (*lv*) latex vessel, (*m*) megasporange, (*me*) megagamete, (*mimc*) microspore mother cell, (*n*) nucleus, (*ob*) obturator, (*ow*) ovary wall, (*p*) petals, (*pa t*) parietal tissue, (*pe*) pericarp, (*pl*) placenta, (*pn*) polar nuclei, (*ptn*) pollen tube nucleus or vegetative nucleus, (*s*) sepals, (*sc*) seed coat, (*sd*) seed, (*se*) septum, (*st*) stamens, (*sti*) stigma, (*sty*) style, (*sy*) synergids, and (*vb*) vascular bundle.

PLATE I

Fig. 1. Longitudinal section of a young floral primordium at the axil of a bract. × 53.

Fig. 2. Longitudinal section of a floral primordium showing the beginnings of the sepals.. × 53.

Fig. 3. A floral primordium showing the stamens. × 28.

Fig. 4. An older floral primordium showing the petals already differentiated. × 28.

Fig. 5. A still older floral primordium showing all its parts (except the disc) well differentiated. × 28.

Fig. 6. Longitudinal section of a young flower showing the origin of the megasporanges. × 53.

Fig. 7. Older carpels showing their fusion; megasporanges arising from the base of the ovarial cavity; darkened area is locule, or cell. × 89.

Fig. 8. Still older carpels showing more developed megasporanges. × 53.

Fig. 9. Much older pistil showing stigma, style and megasporanges; note the disc. × 53.

Fig. 10. Transverse section of ovary showing placentas and megasporanges; darkened areas are cells. × 53.

Fig. 11. Diagram of a transverse section of a single flower showing relative positions of nearly all its parts. × 28.

Fig. 12. Diagram of a longitudinal section of a megasporange showing its nucellus (darkened) and its massive integument. × 53.

Fig. 13. Showing megaspore mother cell in the scanty nucellus of a megasporange. × 540.

Fig. 14. Showing two of the three megaspore mother cells from a megasporange. × 540.

Fig. 15. Megaspore mother cell enlarging; nucellar tissue being destroyed and distended; integument has covered the nucellus. × 540.

Fig. 16. Tetrad; chalazal megaspore becoming functional. × 540.

Plate II

Fig. 18. Diagram of a longitudinal section of an older megasporange showing the elongated embryo sac (8-nucleate stage). × 28.

Fig. 19. Quadri-nucleate megagametophyte; sac has elongated through the slender micropyler canal formed by the enlarged integument. × 235.

Fig. 20. Portion of the chalaza of the embryo sac from fig. 18, showing seven nuclei; the eighth nucleus could not be located. × 235.

Fig. 21. Portion of embryo sac prior to complete differentiation of its contents; note five of the nuclei migrating to the micropylar end, while the three remain at the chalaza, these exhibiting early degeneration. × 410.

Fig. 22. Egg apparatus and polar nuclei of a mature megagametophyte. × 410.

Fig. 23. Portion of a transverse section of an anther showing microspore mother cells. × 540.

Fig. 24. Microspore mother cell with its cytoplasm separated from the mother wall. × 890.

Fig. 25. Microspore mother cell dividing; its cytoplasm separated from the mother wall and provided with a special mucilaginous coat. × 540.

Fig. 26. Microspore mother cell with three of its daughter nuclei resting; no walls are formed between them; mucilaginous coat much more differentiated. × 540.

Fig. 27. Tetrads; mother wall (not shown here) still persisting and the special mucilaginous wall intact. × 540.

Fig. 28. A single microspore. × 540.

Fig. 29. A diagram of a transverse section of a young fruit showing one of the megasporanges developing. × 7.

PLATE III

Fig. 30. Diagram of a longitudinal section of a young capsule showing one of the megasporanges developed. × 7.

Fig. 31. Portion of the pericarp taken at *a* from fig. 30. × 235.

Fig. 32. Portion of the pericarp taken at *b* from fig. 30. × 235.

Fig. 33. Portion of a transverse section of the pericarp prior to lignification. × 235.

Fig. 34. Portion of a transverse section of the seed coat showing its early differentiation on the third hypodermal layer of cells. × 235.

Fig. 35. Portion of the seed coat showing radially palisaded or elongated cells derived from the third hypodermal layer of cells of the integument. × 235.

Fig. 36. Portion of the seed coat taken across the micropyle (from *c* of fig. 30). × 235.

Fig. 37. Portion of a longitudinal section of the mature seed coat. × 235.

Fig. 38. Stellate cells from the micropyler portion of the young seed obtained below the palisaded tissue of the coat. × 235.

Fig. 39. Diagram of a transverse section of a young fruit showing the septum and four of the megasporanges apparently enlarging simultaneously. × 7.

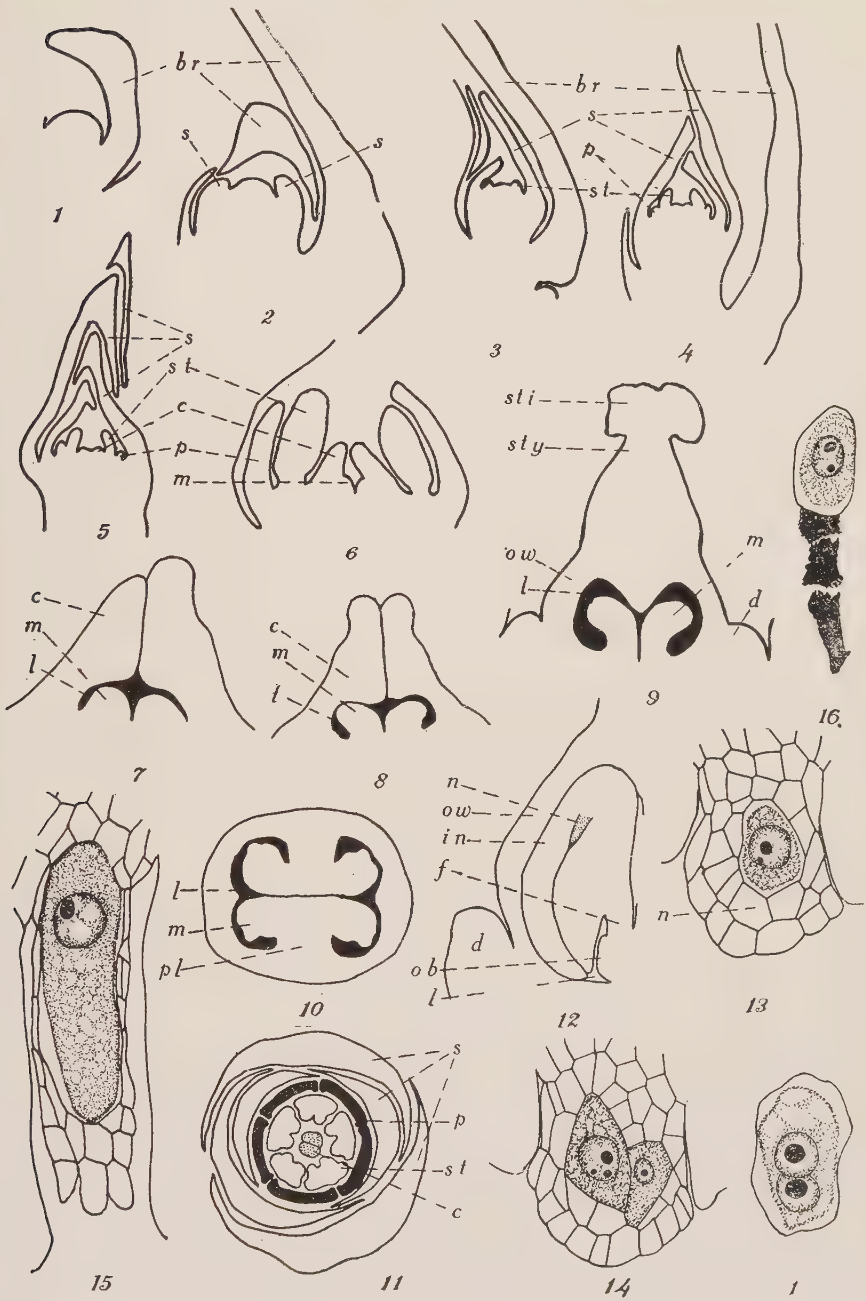


PLATE I

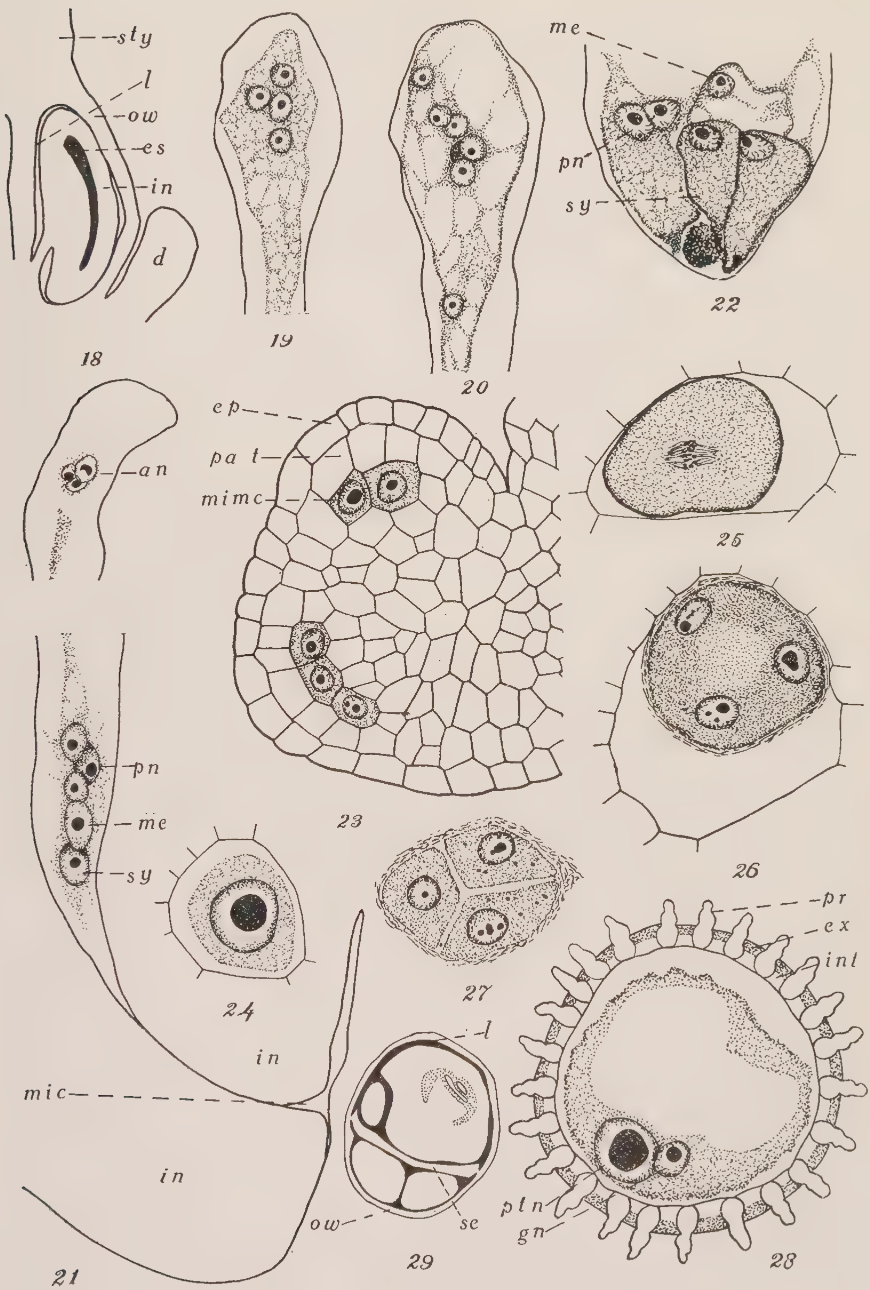

sty
l
ow
es
in
d
18
19
20
me
pn
sy
22
an
ep
pat
mimc
23
25
26
pn
me
sy
24
27
pr
ex
int
in
mic
in
l
ow
sc
29
ptn
gn
28
21

PLATE II

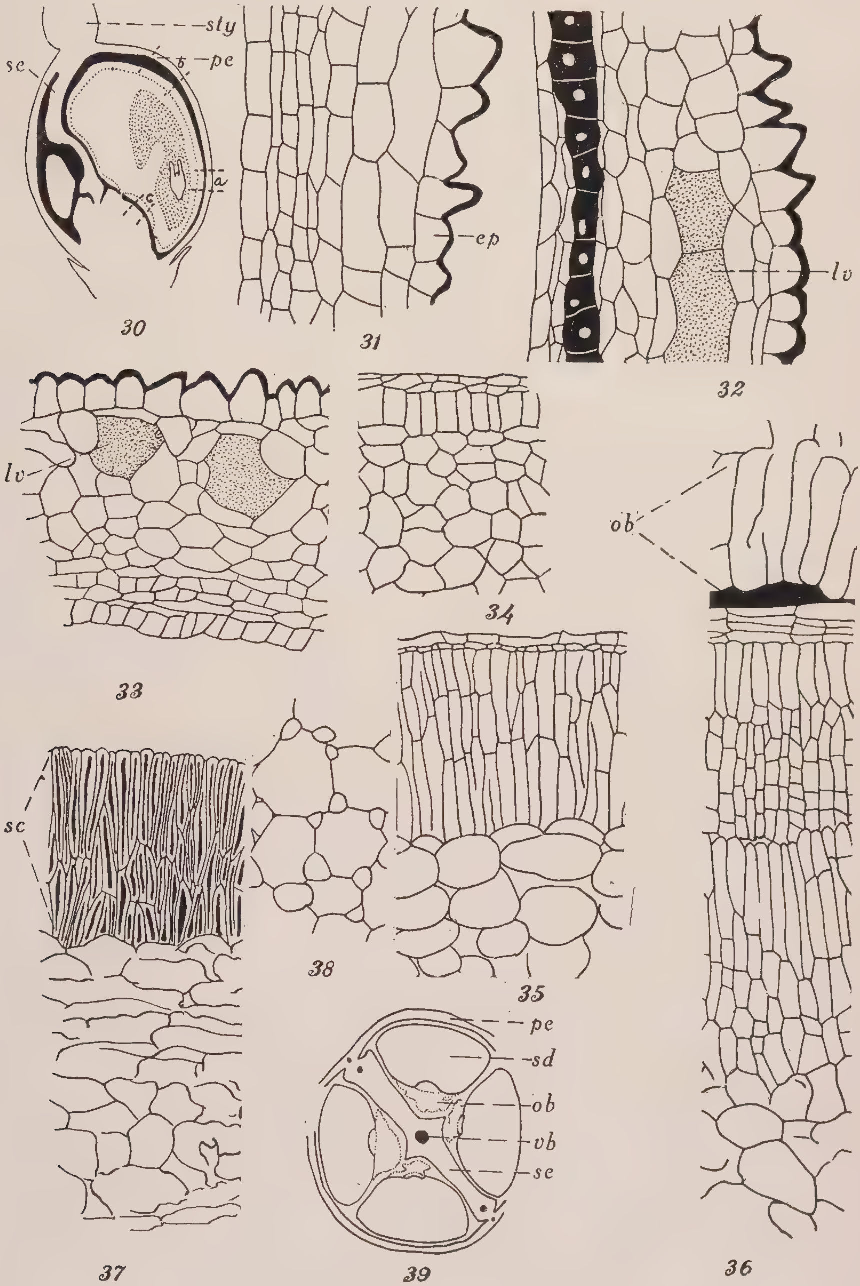


PLATE III

STUDIES ON SURRA: II. NATURAL RECOVERY FROM SURRA INFECTION AMONG OXEN AND WATER BUFFALOES

MIGUEL MANRESA AND B. M. GONZALEZ
Of the Department of Animal Husbandry

Much of what has been written regarding the recovery from surra infection is vague and, at times, conflicting. Moberly (1908) makes the statement, based on experience in the Philippine Islands, that cattle and carabaos which show little evidence of surra disease while suffering from it may ultimately recover; that only a small percentage die, so long as they are kept under favorable conditions; but, if they are crowded closely together or become sick with any other disease that causes fever, they generally die.

It is not certain whether by recovery Moberly meant the complete absence of the infective organisms in the body tissues of the host, or only the periodical centralization of the *Trypanosomes* with subsidence of the acute symptoms; the latter is the meaning presumably expressed by Hutyra and Marek (1920) when they state that "cattle and zebus are generally considered as virus carriers harboring the *Trypanosome* organisms in their blood for years," and that during such periods the *Trypanosomes* are found only rarely in the blood, and in great numbers only during the febrile attack, but that "after recovery they may remain in the blood for months." This view is supported by Bubberman (1930), based on his experiences in Java. He states that in the great majority of surra cases the resisted infection becomes dormant.

Citing the work of Cross (1921) who made a special study of the surra disease in camels, oxen, water buffaloes, and horses in India, J. T. Edwards (1926) states that in the chronic form the course of the disease extends from two to five years; the animals become greatly emaciated, develop paralysis of the limbs, and finally die showing symptoms of severe anemia. Virulent outbreaks of surra among oxen and water buffaloes have been reported by C. W. Edwards (1916), J. T. Edwards (1926), Manresa (1935), and others in which high mortality rates were said to supervene. It is generally agreed, however, that the disease runs a deadly course with

[1] Experiment Station contribution No. 1017. Received for publication on January 11, 1935.

acute and subacute symptoms only in the horse and dog, that oxen, water buffaloes and camels may carry the *Trypanosoma evansi* organisms in the latent state of activity without displaying any manifestation of ill health.

J. T. Edwards (1926) makes the statement that "the indigenous cattle in India are capable of acting as reservoirs of the *Trypanosomes,* probably during the whole life of the animal". A similar statement was made by Kelser (1927) to the effect that in the Philippine Islands, carabaos, and to a lesser extent, cattle are common reservoirs of the *Trypanosoma evansi.* Under normal conditions the affected animals suffer no impairment of health whatever; only when their normal resistance is lowered can the surra parasites multiply rapidly, and in such cases the carrier is a particularly dangerous source of infection.

EXPERIMENTAL RESULTS

In the course of the work in our Department of Animal Husbandry, case records have been accumulated tending to show that definite recovery, without medication, occurs both in the taurine and bubaline species of cattle, with complete disappearance of the infective organisms from the body tissues of the host. These accumulated data are the logical consequence of the program adopted in the control and eradication of surra disease which broke out among the animals belonging to the College of Agriculture in December, 1933. (Manresa, 1935).

Among other things, the program called for microscopical examinations, complement-fixation and animal inoculation tests of all susceptible animals at suitable intervals. From those animals showing strong positive reaction in the complement-fixation tests samples of blood were taken and injected into white rats. If the inoculation proved positive, the infected animals were immediately placed in the Isolation Barn which is protected from flies by fine wire screen netting. Thereafter, regular microscopical examinations, complement-fixation tests and animal inoculations were made at suitable intervals.

Table 1 shows the results of subsequent complement-fixation tests for surra on fourteen oxen which were found to be positive for surra by the complement-fixation test made by the U. S. Army Medical Research Board on January 26, 1934. The Army Medical Research Board was kind enough to extend cooperation in testing our animals, and when the Board was transferred to the Panama Canal Zone in June, 1934, negotiations were made with the local Bureau of Animal

Industry for the continuation of these tests, thus the accumulation of these data became possible.

It may be seen in table 1 that animals Nos. 110 and 174 were already negative for surra on July 30, 1934 by the complement-fixation test; animals Nos. 57 and 215 were also negative on November 8, 1934; and animals Nos. 42, 47, 52, 59, 62, 93, 130, 182, and 190 were negative on December 13, 1934. Cow No. 49 was negative on November 8 and December 13, 1934. Microscopical examinations of the blood of these animals made at intervals of about ten days from December 5, 1933 to the writing of this paper on December 31, 1934, a period of over one year, failed to show the *Trypanosome* organisms.

The period intervening from the time these animals were found positive for surra by the complement-fixation test on January 26, 1934 to the time they tested negative which varied from six to ten months, as may be seen in the table, should not be taken as the shortest period when the change in the reaction to the test from positive to negative results takes place, because these cases were chance observations, not studies specifically made for the purpose of determining length of period. We have recorded cases both in taurine and bubaline species of cattle wherein recovery from surra appears to have occurred within a period of one month. It may be seen in the table that natural recovery from surra is not affected by the age, breed or sex. These animals varied from one to thirteen years old and included Philippine oxen, Indian Nellore, as well as crossbreeds containing blood of the Hereford and Holstein breeds.

These cases of apparent spontaneous recovery, without medication, from the surra disease appeared to be sufficiently striking to warrant critical study, and the question that came up was what criteria to use in determining the existence of definite recovery, meaning by the term "recovery" the absence of the infective organism from the body tissue of the host. It was thought that if an animal is found infected with surra by actual presence of the trypanosomes in its blood, it can be considered as having subsequently recovered definitely from the infection when the following conditions shall have been fulfilled: (1) Negative for not less than four weeks in the daily microscopical blood examinations. (2) Laboratory animals inoculated with large doses of its blood do not die. (3) It gives repeated negative reaction with the complement-fixation test. Therefore, these three criteria were used in our studies.

The first critical evidence of definite natural recovery from surra was brought to light in cow No. 156, named Dolores, shown in table

2. This cow gave a positive reaction in the complement-fixation test on January 26, 1934, and the *Trypanosome* organisms were seen in the peripheral circulation on April 12, 1934. The second complement-fixation test made on the animal on May 10, 1934 gave the result "suspicious". All microscopical examinations of the blood made at intervals of about one week from May 13, 1934 to the writing of this paper on December 31, 1934 failed to show the presence of the parasites causing surra, and the complement-fixation test on November 8, 1934 was negative. A white rat was inoculated with 3.5 ml. of the blood of this cow on December 11, 1934 and at the present writing the rat's blood has not shown any *Trypanosomes* in the daily microscopical examinations.

Cow No. 198, named Nicolasa, was also positive for surra by the complement-fixation test on January 26, 1934. A white rat inoculated with one ml. of the blood of this cow showed numerous *Trypanosomes*[2] in the peripheral blood on the sixth day after inoculation and died on the fourteenth day after inoculation. The same kind of *Trypanosome* organisms were detected in the peripheral blood of cow No. 198 on April 11, 1934. Three days later, that is, on April 14, the positive reaction to the complement-fixation test was given by the animal, thus confirming the finding under the microscope. On May 10, 1934 the animal was tested again by complement-fixation, but was found negative. Weekly microscopical examination tests on the blood from May 10 up to this writing have all been negative. Another negative complement-fixation test was obtained on August 29, 1934. A white rat inoculated on December 11, 1934 with 2.5 ml. of the blood of this cow has not shown any *Trypanosomes* in the daily microscopical examinations.

Steer No. 166, named Eugenio, exhibited the *Trypanosoma evansi* organisms in the peripheral blood on February 22, 1934. One ml. of the blood of this steer was inoculated into a white rat which disclosed the parasites 5 days after infection and died three days later with characteristic symptoms of surra, both clinically and by post-mortem lesions. However, the complement-fixation test made on steer No. 166 on April 19, 1934 was negative. The animal was tested subsequently two times for surra by the complement-fixation method on May 10 and on August 29, 1934; the results of these tests were both negative, as may be seen in table 2. The microscopical

---

[2] Samples of these *Trypanosomes* were sent to Dr. M. A. Tubangui of the Bureau of Science, Manila, for identification and the report was that they were *Trypanosoma evansi*.

examination of the blood of this animal made every week from April 13 up to this writing did not reveal the presence of any of the parasites causing surra. A rat inoculated with the blood of this steer remained negative for the surra parasites in microscopical examinations for 41 consecutive days, and when discarded from the experiments 100 days after the inoculation it was vigorous and free from any *Trypanosomes* in the peripheral blood.

Extended critical tests were secured from cow No. 121, named Caroline, which was found positive for surra by repeated complement-fixation tests, microscopical examination, and animal inoculations, as may be noted in table 2. One white rat and one Philippine Native pony, inoculated with small doses (1 ml.) of the blood of this cow, contracted the infection and died showing the characteristic symptoms of surra, both clinically and by the post-mortem lesions. July 30, 1934 a third white rat was inoculated with 4 ml. of the blood of the cow; this rat never showed any *Trypanosomes*, and on December 31, 1934, that is, 156 days after inoculation, the rat was still living and vigorous and free from infection. On July 30, 1934 the cow was tested for surra by complement-fixation, to which she reacted "weakly positive", with one of four tubes showing a positive reaction. A horse was inoculated with 4 ml. of the blood of the cow on August 29, 1934. The horse was complement-fixation negative before inoculation. Microscopical examination of the blood of the horse for 60 consecutive days and less frequently thereafter failed to show any *Trypanosomes*. Complement-fixation test on the horse on September 20, 1934, that is, 22 days after inoculation, was negative. On December 31, 1934, that is, 124 days after inoculation the horse was vigorous and free from surra infection. Two other complement-fixation tests made on cow No. 121 on August 29 and November 8, 1934 gave "weakly positive" results. A fourth rat inoculated on October 27, 1934 with 5 ml. of the blood of the cow has remained negative for *Trypanosomes* in the daily microscopical examination, and at this writing 65 days after inoculation, the rat is vigorous. On December 13, 1934, this cow was found negative for surra by the complement-fixation test.

Table 3 gives the data on natural recovery from surra among the bubaline species of cattle, more popularly known as carabaos. Carabao No. 93, named Diodati, disclosed the *Trypanosome* organisms under the microscope on February 28, 1934. Microscopical examinations showed it to be positive on March 1, 7 and 8, 1934; after these dates, all examinations were negative. On April 19, 1934, this cara-

bao was tested for surra by complement-fixation and found negative. Another complement-fixation test made on May 10, 1934 also proved negative. Carabao No. 57, named Albion, had a similar history. It showed the presence of the organisms in the peripheral blood on March 27, 1934. Subsequently, this carabao was tested by complement-fixation two times, on April 19 and on November 8, 1934, both tests proving negative. Indian water buffalo No. 31, named Fabian was found by the complement-fixation test on January 26, 1934 infected with surra. Two rats inoculated with the blood of this Indian buffalo on March 14 and April 19, 1934 became ill with trypanosomiasis, showing the characteristic symptoms of surra and died in about two weeks after inoculation. After a time, the water buffalo was tested by complement-fixation twice, on September 20 and on November 8, 1934, and the results were negative. Grade Indian buffalo No. 68, named Bukidnon, aged 5 years, was found positive for surra on January 26, 1934. A white rat inoculated with 2 ml. of the blood of this buffalo on March 14, 1934 exhibited *Trypanosome* organisms in the peripheral circulation on March 27 and died on March 31, 1934. The inoculated rat showed the characteristic symptoms of surra both clinically and by post-mortem lesions. The complement-fixation test on the carabao made on March 14, 1934 was positive. When tested again for surra on December 13, 1934 by the complement-fixation test the carabao was found negative.

Regular microscopical examination tests of the blood of the carabaos listed in table 3 from the time they became negative to the complement-fixation tests failed to disclose any *Trypanosome* organisms. Animal inoculations have all been negative. As with the oxen it appears that age and the breed of the water buffaloes are not factors in the natural recovery from the infection of surra.

In all these tests we have never had a single case where an animal exhibiting the trypanosome organisms in the peripheral blood has tested negatively in the complement-fixation tests. On the contrary, invariably all the animals found positive for trypanosomiasis under the microscope have proved positive by complement-fixation also. In due time the results of this and other phases of the experiment will be reported on in detail. For the present, it seems important to at least mention that we have found very strong evidences of the existence of individual resistance against the disease in both the oxen and water buffaloes. These evidences are furnished by the animals which have remained negative by repeated complement-fixation tests although they had been herded together with surra infected animals for as long as one year. This condition could not be attributed to the

absence of insect vectors inasmuch as our studies on the incidence of the tabanid flies, acknowledged as the most important factor in the dissemination of surra, showed that these flies are ever present on the College of Agriculture fields the whole year round. The only time we could not get them was when we did not go out to collect.

DISCUSSION OF RESULTS

Investigations have been conducted in the Philippines and elsewhere in the attempt to disclose the mechanics of transmission of *Trypanosome* parasites from animal to animal (Kelser, 1927; Bubberman, *et al*, 1930). In most cases it was shown that the rôle which insect vectors play in the spread of the infection is physical, not biological. No satisfactory explanation, however, has been offered to account for the periodical remission and exacerbation of the symptoms of the disease in the different species of animals in a given surra infected area, nor for the complete disappearance of the disease, followed generally by an increase of the animal population, including horses, in the locality or region.

The serious outbreak of surra which occurred on the island of Marinduque in 1909 is a case in point. It is said that a large number of animals became infected with surra with resulting high mortality. The Bureau of Agriculture attempted to control the disease by destruction of the infected animals (Conner, 1910). A total of 779 animals were found, presumably by microscopical examination, to be infected, of which 329 were killed. The number reported as having died was 166. In the report regarding the result of the work of the Bureau which the Director of Agriculture submitted one year later [3] the statement is made that on the island of Marinduque so many carabaos harbored the infection that both officials and the people opposed the work of eradication. Notwithstanding this fact the live stock population on the island of Marinduque increased, as may be seen in the following tabulation:

Number of animals on the island of Marinduque in the years 1903 and 1918. (Data taken from the Philippine Census, 1903, and 1918).

Kinds of animals	*1903*	*1918*
Carabaos	2,500	9,660
Cattle	3,943	13,606
Horses	3,894	4,832 [4]

[3] NESOM, G. E. 1911. Report of the Director of Agriculture for the fiscal year ending June 30, 1910. The Philippine Agric. Rev. 4 (1): 22–23.

[4] The number of horses reported in 1919 was 4,983. The Philippine Agric. Rev. 14: 139.

Similar observations on the increase in the animal population following the appearance of surra with consequent death of a large number of susceptible animals do not seem to be confined to the island of Marinduque alone, but have been reported from every surra infected locality in the Philippines. Of the total of 7,199 horses, 939 oxen and 1,693 water buffaloes examined for surra by the Bureau of Agriculture in the course of two years (Nesom, 1909 and 1910), 359 horses, 1 ox and 27 carabaos were found infected under the microscope. Director Nesom reported that the disease spread very rapidly throughout the Philippines. The 1909 report of the infection had come from 18 provinces. This number was increased to 29 a year later, and by 1911 according to Nesom (1911) "surra has been found in nearly all provinces of the Philippines at some time or another." As no satisfactory treatment against surra, either curative or preventive, has been discovered, no special campaign against the disease was undertaken by the Bureau of Agriculture before 1920 or later (Youngberg, 1917, 1918, 1919). Yet, despite this lack of control measures there has been an uninterrupted increase of the live stock population.

Statistical data on the number of carabaos, oxen and horses in the Philippines in 1902, from 1910 to 1919 and from 1931 to 1932 are given below:

The number of carabaos, oxen and horses in the Philippine Islands in 1902, from 1910 to 1919, inclusive, and from 1931 to 1932 inclusive.

YEAR	CARABAOS	OXEN	HORSES	SOURCES OF DATA
1902....	640,871	127,559	144,171	Philippine Census, 1903
1910....	705,758	243,180	138,199	
1911....	809,267	289,771	146,641	
1912....	911,318	339,202	162,383	
1913....	1,047,164	418,114	179,089	The Philippine Agric. Rev.
1914....	1,147,433	477,736	215,826	14: 149. 1920
1915....	1,221,966	534,123	223,195	
1916....	1,228,836	567,456	203,564	
1917....	1,271,208	603,107	214,209	
1918....	1,463,200	615,449	226,964	Philippine Census, 1918
1931....	2,149,652	1,292,381	319,421	The Philippines Herald
1932....	2,192,904	1,320,980	423,669	Year Book, Sept., 1934

It may be seen from the foregoing tabulation that even during the years 1910 to 1912 when surra epizootic coexisted with rinderpest the increase in the population of animals in the Philippine Islands kept a very regular upward trend. In the period of twenty-two years, that is, from 1910 to 1932 the carabaos and horses more than

trebled in number and the oxen more than sextupled. And that this increase in animal population despite the existence of surra epizootic is not confined to Philippine environment but obtains in other countries such as India is apparent in the statement of J. T. Edwards (1926): "considering that the bovine trypanosomiasis has such a widespread distribution in India, it is remarkable that the equine affection is not more common than it is, having in mind that surra spreads naturally rather rapidly among horses when cases commence to appear in these animals." Kelser (1927) was led by Philippine observations similar to those of Edwards to suspect that the intervention of permanently infected insect vectors, believed by some investigators to be important in the dissemination of the disease, plays a rather insignificant rôle. He states that "if surra were spread in such a manner the equine population of the Philippine Islands would have been wiped out long ago."

We are inclined to the view that the intervention of biological insect vectors is not essential in the transmission of surra organisms from animals of the same species or from one species to other species, if it be accepted that some species, such as oxen and water buffaloes, act as permanent carriers of the organism, for it has been amply shown by numerous investigators, as, Mitzmain (1912 and 1913); Kelser (1927), Bubberman and co-workers, (1930); and others, that the insects acting as mechanical transmitters of the infection are so generalized, both as to number and species, as to be almost beyond control. Our studies, now covering one year, of the incidence of one of the species of insects, *Tabanus striatus*, which act as mechanical transmitters of *Trypanosomes*, show that the Tabanid flies are present on the College Campus throughout the year. Yet, it appears that, as in other localities, the surra disease on the College of Agriculture Campus will soon be past history.

In view of the present finding, it appears to us that a revision is needed of the assumption so generally held that oxen and water buffaloes once infected remain infected during their whole lifetime, for we have found that natural recovery occurs. Should this finding prove to be of general occurrence in species of animals other than the taurine and the bubaline species, it may explain the gap that has puzzled all research workers on surra. On the basis of the results here presented, the hypothesis may be offered that in any locality the animals are classified into three general groups, with respect to their susceptibility to surra; namely, the resistant, the susceptible, and the indifferent groups. Under normal conditions in animals belonging to the resistant group the *Trypanosome* organisms do not

thrive in their system. The susceptible animals are readily infected, showing the acute symptoms of the disease and then dying; the indifferent ones are affected in such a way that they tolerate the infection in varying degrees, and may eventually get rid of it, if under favorable conditions the protective agencies of the body can be enhanced.

This hypothesis, we believe, will account for the upward trend of the animal population in any given surra infected locality or region. For, with the elimination of the susceptible animals a relative increase in the number of the resistant ones within the population would take place. These animals will increase in spite of the presence of the scourge. The animals belonging to the indifferent group, however, will undoubtedly produce offspring which differ in their reaction to the disease and the susceptible individuals will keep on dying off as long as the infection persists. It seems to be reasonable to assume that in time these susceptible individuals will be eliminated, and the disease will vanish with them. This explanation, by the way, may account to a certain extent, for the present state of rinderpest in the Philippines and it would be of great value to determine whether the decrease of rinderpest cases is due to the artificial intervention, such as the use of biologics, or to natural selection. It is obvious that the problem brought by the data here presented is so important that work along the lines they suggest should be continued and undertaken on a much larger scale. The rôle of heredity and the interaction of other factors, both natural and artificial, such for example, as the use of chemotherapeutic agents must be properly evaluated.

SUMMARY

1. Data on studies on surra are reported in this paper to answer the question: Is there recovery from surra in oxen and water buffaloes? The word "recovery" is used in this paper to mean definitely "complete recovery", with absence of infecting organisms from the body tissues of the host.

2. Natural recovery was found to occur spontaneously among animals belonging to the taurine and bubaline species of cattle. A provisional working hypothesis is offered which may account for the regular upward trend in the number of animals in a given locality or region following the outbreak of surra epizootics.

3. It is recommended that further work be undertaken particularly along the lines suggested by the data obtained in the present studies. The rôle of heredity and the interaction of the various

factors, both natural and artificial, must be properly evaluated for the proper understanding of the problem before standard measures of control can be advocated.

ACKNOWLEDGMENTS

The writers wish to acknowledge their indebtedness to the U. S. Army Medical Research Board and to the Bureau of Animal Industry for cooperation received, without which these experiments would have been incomplete. Special thanks are due to Colonel Geo. H. Koon, Major Raymond Randall, Lieut. A. T. Thompson, and Drs. V. Buencamino, T. Topacio, N. S. Sevilla and R. A. Acevedo for their cooperation in the conduct of the complement-fixation tests.

LITERATURE CITED

BUBBERMAN, C. C. 1930. The fight against Trypansomiasis in Netherlands-Indies. English translation from the original, by Dr. S. Youngberg. Bureau of Animal Industry, Manila, P. I. Eleventh International Veterinary Congress. London, p. 1–8.

CROSS, H. E. 1921. The course that camel surra runs in ponies, buffaloes, and other animals. Agric Res. Inst. Pusa, Bull. 99: 1–19. *Fig. 3.*

CONNER, M. C. 1910. Report of the Bureau of Agriculture for the fiscal year ending June 30, 1909. The Philippine Agric. Rev. **3**: 24–25.

EDWARDS, C. W. 1916. The live stock industry of the Philippines. The Philippine Agric. Rev. **9**: 136–149. *Pl. 7–12.*

EDWARDS, J. T. 1926. The chemotherapy of surra of horses and cattle in India. Jour. Compar. Pathol. and Therap. **39** (2): 83–112.

HUTYRA, FRANZ, AND JOSEF MAREK. 1920. Special pathology and therapeutics of the diseases of domestic animals. Vol. 1, 1199 p.n., 231 illus. Chicago, U. S. A.: Alexander Eger.

KELSER, R. A. 1927. Transmission of surra among animals of the equine species. Philippine Jour. Sci. 34 (2): 115–139. *1 pl.*

MANRESA, MIGUEL. 1935. Studies on surra: I. The outbreak of surra in the College of Agriculture in 1933. The Philippine Agriculturist 23: 749–757.

MITZMAIN, M. BRUIN. 1912. Collected notes on the insect transmission of surra in carabaos. The Philippine Agric. Rev. **5**: 670–681.

MITZMAIN, M. BRUIN. 1913. The surra-conveying fly of the Philippines and some factors concerned in the control measures. The Philippine Agric. Rev. **6**: 371–379.

MOBERLY, DAVID G. 1908. Common dangerous communicable diseases of domestic animals in the Philippine Islands. The Philippine Agric. Rev. **1** (3): 119–122.

YOUNGBERG, STANTON. 1917. Résumé of the work of the veterinary division for the year 1916. The Philippine Agric. Rev. **10**: 175–188.

YOUNGBERG, STANTON. 1918. Résumé of the work of the Veterinary Division for the year 1917. The Philippine Agric. Rev. **11**: 83–95.

YOUNGBERG, STANTON. 1919. Surra. The Philippine Agric. Rev. **12** (4): 35.

TABLE 1

Showing the results of complement-fixation tests for surra on oxen previously found positive for surra by this test

ANIMALS				DATE (1934)	RESULTS OF THE TEST	COMPLEMENT-FIXATION TEST MADE BY
Name	No.	Blood composition	Age (years)			
Rebecca	110	Philamin	8	Jan. 26	Positive	U. S. Army Med. Res. Board
				July 30	Negative	Bur. Animal Indus.
Matea	174	Native	9	Jan. 26	Positive	U. S. Army Med. Res. Board
				July 30	Negative	Bur. Animal Indus.
Venus	57	Nellore-Native	13	Jan. 26	Suspicious	U. S. Army Med. Res. Board
				Nov. 8	Negative	Bur. Animal Indus.
Omana	215	Native	2	Jan. 26	Positive	U. S. Army Med. Res. Board
				Nov. 8	Negative	Bur. Animal Indus.
Marcia	49	Nellore	10	Jan. 26	Positive	U. S. Army Med. Res. Board
				Aug. 29	Anti-complementary	Bur. Animal Indus.
				Nov. 8	Negative	Bur. Animal Indus.
				Dec. 13	Negative	Bur. Animal Indus.
Amara	42	Nellore	6	Jan. 26	Positive	U. S. Army Med. Res. Board
				Dec. 13	Negative	Rur. Animal Indus.
Ira	47	Nellore	11	Jan. 26	Positive	U. S. Army Med. Res. Board
				Dec. 13	Negative	Rur. Animal Indus.

TABLE 1—(Continued)

ANIMALS				DATE (1934)	RESULTS OF THE TEST	COMPLEMENT-FIXATION TEST MADE BY
Name	No.	Blood composition	Age (years)			
Daisy	52	Nellore	4	Jan. 26	Positive	U. S. Army Med. Res. Board
				Dec. 13	Negative	Bur. Animal Indus.
Miss Boñgabon	59	Nellore	10	Jan. 26	Positive	U. S. Army Med. Res. Board
				Dec. 13	Negative	Bur. Animal Indus.
Jacoba	62	Nellore	1	Jan. 26	Positive	U. S. Army Med. Res. Board
				Mar. 14	Positive	U. S. Army Med. Res. Board
				Apr. 18	Positive	U. S. Army Med. Res. Board
				Dec. 13	Negative	Bur. Animal Indus.
Provincial Fair	93	Philamin	9	Jan. 26	Positive	U. S. Army Med. Res. Board
				Dec. 13	Negative	Bur. Animal Indus.
Luz	130	Hereford-Nellore	6	Jan. 26	Positive	U. S. Army Med. Res. Board
				Dec. 13	Negative	Bur. Animal Indus.
Bonifacia	182	Philamin	3	Jan. 26	Positive	U. S. Army Med. Res. Board
				Dec. 13	Negative	Bur. Animal Indus.
Georgia	190	Grade Holstein	3	Jan. 26	Positive	U. S. Army Med. Res. Board
				Dec. 13	Negative	Bur. Animal Indus.

TABLE 2

Showing the results of microscopical examinations, animal inoculations, and the subsequent complement-fixation tests on the taurine species of cattle infected previously with surra

DATE (1934)	RESULTS OF COMPLEMENT-FIXATION TEST	RESULTS OF MICROSCOPICAL EXAMINATION	RESULTS OF ANIMAL INOCULATIONS	REMARKS
Animal: Cow No. 156, named Dolores; blood composition, Indian Nellore-Native; age, 5 years.				
Jan. 26	Positive			Tested by the U. S. Army Med. Res. Board.
April 12		Positive.		Several *Trypanosomes* were seen under the microscope.
May 10	Suspicious			Tested by the U. S. Army Med. Res. Board.
May 13		Weekly microscopical examination started. Previous to this date examination was made daily.		No *Trypanosomes* could be found in the weekly examination of the blood.
Nov. 8	Negative			Complement-fixation test by the Bur. Animal Indus.
Dec. 11			White rat was inoculated with 3.5 ml. of the blood.	Results, negative.

TABLE 2 (Continued)

DATE (1934)	RESULTS OF COMPLEMENT-FIXATION TEST	RESULTS OF MICROSCOPICAL EXAMINATION	RESULTS OF ANIMAL INOCULATIONS	REMARKS
Animal: Cow No. 198, named Nicolasa; breed, Philippine Native; age 4 years.				
Jan. 26	Positive			Complement-fixation test by the U. S. Army Med. Res. Board.
March 14			White rat inoculated with 1 ml. of the blood of cow 198 showed numerous *Trypanosome* organisms on the 6th day after inoculation.	This rat died of surra 14 days after inoculation.
April 11		Positive.		Several organisms were seen under the miscroscope.
April 14	Positive			Complement-fixation test by the U. S. Army Med. Res. Board.
May 10	Negative			Complement-fixation test by the U. S. Army Med. Res. Board.
May 14		Weekly microscopical examination started. Previous to this date examination was made daily.		No *Trypanosomes* had been found in the weekly examination of the blood up to the writing of this paper, Dec. 31, 1934.
Aug. 29	Negative			Complement-fixation test by the Bur. Animal Indus.
Dec. 11			Another white rat was inoculated with 2.5 ml. of the blood of cow No. 198.	Results, negative.

TABLE 2 (Continued)

DATE (1934)	RESULTS OF COMPLEMENT-FIXATION TEST	RESULTS OF MICROSCOPICAL EXAMINATION	RESULTS OF ANIMAL INOCULATIONS	REMARKS
Animal: Steer No. 166, named Eugenio; breed, Nellore-Native; Age, 5 years.				
Feb. 22		Positive.		Several *Trypanosome* organisms were seen under the microscope.
March 14			White rat was inoculated with 1 ml. of the blood of steer No. 166. It became infected with surra organisms 5 days after inoculation.	The rat died of surra 8 days after inoculation.
April 13		Weekly microscopical examination was started. Previous to this date examination was made every day.		No *Trypanosomes* had been found in the weekly examination up to the writing of this paper, Dec. 31, 1934.
April 19	Negative			Complement-fixation test by the U. S. Army Med. Res. Board.
April 19			Another white rat was inoculated with 1 ml. of the blood of this steer. No *Trypanosomes* were found in 41 days of daily microscopical examination nor in the weekly tests thereafter. On July 28, 1934 (100 days after inoculation) when the rat was discarded it was vigorous.	
May 10	Negative			Complement-fixation test by the U. S. Army Med. Res. Board.
Aug. 29	Negative			Complement-fixation test by the Bur. Animal Indus

TABLE 2 (Continued)

DATE (1934)	RESULTS OF COMPLEMENT-FIXATION TEST	RESULTS OF MICROSCOPICAL EXAMINATION	RESULTS OF ANIMAL INOCULATIONS	REMARKS
Animal: Cow No. 121, named Caroline; blood composition, Grade Hereford; Age, 8 years.				
Jan. 26	Positive			Complement-fixation test by the U. S. Army Med. Res. Board.
Feb. 12		Positive.		The smears were teeming with *Trypanosome* organisms.
March 14	Positive			Complement-fixation test by the U. S. Army Med. Res. Board.
March 14			White rat inoculated with 2 ml. of the blood from cow 121, exhibited the *Trypanosomes* in the blood stream 5 days after inoculation.	The rat died of surra 14 days after the inoculation.
April 2			Another rat was inoculated with 3 ml. of the blood.	This rat developed *hematoma* under the skin which when removed by surgical operation caused death immediately.
April 19			A Philippine Native pony was inoculated with 2 ml. of the blood of cow No. 121. *Trypanosome* organisms were found in the pony 5 days after inoculation.	The pony developed the characteristic symptoms of surra and died 55 days after inoculation.
April 19	Positive			Complement-fixation test by the U. S. Med. Res. Board.
July 30			Third white rat was inoculated with 4 ml. of the blood of same cow. This rat showed no *Trypanosomes* in the daily or weekly microscopical examinations.	On Dec. 31, 1934 or 156 days after inoculation, the rat was still living and vigorous.

TABLE 2—(Continued)

DATE (1934)	RESULTS OF COMPLEMENT-FIXATION TEST	RESULTS OF MICROSCOPICAL EXAMINATION	RESULTS OF ANIMAL INOCULATIONS	REMARKS
July 30	Weakly positive			Complement-fixation test by the Bur. Animal Indus.
Aug. 29			Another Philippine pony was inoculated with 4 ml. of the blood of cow No. 121 The pony showed no *Trypanosomes* in the daily or weekly microscopical examinations.	On Dec. 31, 1934, i. e. 124 days after inoculation, the horse was vigorous and free from surra. This horse was tested by the complement-fixation test before inoculation and 22 days after inoculation, both tests proved to be negative.
Aug. 29	Weakly positive			Complement-fixation test by the Bur. Animal Indus.
Oct. 27			Fourth white rat was inoculated with 5 ml. of the blood of cow No. 121. The rat has not shown any *Trypanosome* organisms in the daily or weekly microscopical tests.	On Dec. 31, 1934, i. e., 65 days after inoculation the rat was vigorous and free from the infection.
Nov. 8	Weakly positive			Complement-fixation test by the Bur. Animal Indus.
Nov. 8			The microscopical test on this cow made daily from Feb. 15, 1934 to Nov. 8, 1934 and weekly thereafter failed to show any *Trypanosomes.*	
Dec. 13	Negative			Complement-fixation test by the Bur. Animal Indus.

TABLE 3

Showing the surra infected water buffaloes (carabaos) which became negative in the subsequent complement-fixation tests

DATE (1934)	RESULTS OF COMPLEMENT-FIXATION TEST	RESULTS OF MICROSCOPICAL EXAMINATION	RESULTS OF ANIMAL INOCULATIONS	REMARKS
Animal: Castrated carabao No. 93, named Diodati; blood composition, 7/8 Indian, 1/8 Native; Age, 3 years.				
Feb. 28		Positive.		Numerous *Trypanosome* organisms were seen under the microscope.
Mar. 1 to Mar. 8		Positive.		The *Trypanosomes* persisted in the peripheral circulation for seven days.
April 19	Negative.			Complement-fixation test by the U. S. Army Med. Res. Board.
May 10	Negative.			Complement-fixation test by the U. S. Army Med. Res. Board.
Aug. 29	Anti-complementary			Complement-fixation test by the Bur. Animal Indus.
Dec. 11			White rat inoculated with 3 ml. of the blood of this carabao.	Negative at the writing of this paper Dec. 31, 1934.
Animal: Castrated Carabao No. 57, named Albion; breed, Native; Age, 7 years.				
Mar. 27		Positive.		Several *Trypanosomes* were seen under the microscope.
April 19	Negative.			Complement-fixation test by the U. S. Army Med. Res. Board.
Nov. 8	Negative.			Complement-fixation test by Bur. Animal Indus.

TABLE 3—(Continued)

DATE (1934)	RESULTS OF COMPLEMENT-FIXATION TEST	RESULTS OF MICROSCOPICAL EXAMINATION	RESULTS OF ANIMAL INOCULATIONS	REMARKS
Animal: Carabao No. 31, named Fabian; breed, Indian water buffalo; Age, 2 years.				
Jan. 26	Positive.			Complement-fixation test by the U. S. Army Med. Res. Board.
Mar. 14			A white rat inoculated with 1 ml. of the blood of Carabao No. 31 exhibited the *Trypanosome* organisms on the 6th day after inoculation.	This rat died of surra 15 days after inoculation.
April 19	Positive.			Complement-fixation test by the U. S. Army Med. Res. Board.
April 19			Another white rat was inoculated with 2 ml. of the blood of carabao No. 31. The rat was found infected with *Trypanosomes* on the 5th day after inoculation.	The rat died showing the characteristic symptoms of surra 11 days after the inoculation.
Sep. 20	Negative.			Complement-fixation test by the Bur. Animal Indus.
Nov. 8	Negative.			Complement-fixation test by the Bur. Animal Indus.
Dec. 11			Third white rat was inoculated with 3 ml. of the blood of this carabao.	Negative under the microscope at the writing of this paper, Dec. 31, 1934.

TABLE 3—(Continued)

DATE (1934)	RESULTS OF COMPLEMENT-FIXATION TEST	RESULTS OF MICROSCOPICAL EXAMINATION	RESULTS OF ANIMAL INOCULATIONS	REMARKS
Animal: Carabao No. 68, named Bukidnon; blood composition, Grade Indian buffalo-Native; Age, 5 years.				
Jan. 26	Positive.			Complement-fixation test by the U. S. Army Med. Res. Board.
Mar. 14			White rat inoculated with 2 ml. of the blood of Carabao No. 68 exhibited *Trypanosome* organisms on the 13th day after inoculation.	This rat died on March 31, 1934 with characteristic symptoms of surra both clinically and by post-mortem lesions.
Mar. 14	Positive.			Complement-fixation test by the U. S. Army Med. Res. Board.
Dec. 13	Negative.			Complement-fixation test by the Bur. Animal Indus.

TWO RUSTS HITHERTO UNREPORTED ON ECONOMIC HOSTS FROM THE PHILIPPINE ISLANDS [1]

G. O. OCFEMIA
Of the Department of Plant Pathology

WITH THREE TEXT FIGURES

The purpose of the present paper is to record two rust fungi hitherto unreported on economic hosts from the Philippine Islands. Although these fungi have been collected and described from specimens coming from other countries they were collected only recently on economic hosts in the Philippines.

One of the rust fungi, *Puccinia tubulosa* (P. and G.) Arth., reported in this paper is heteroecious and both of its hosts occur in these Islands. Stages on the two hosts have been collected in separate localities and at different times. To the teacher of plant pathology in the Philippines the finding of a heteroecious rust is of considerable importance. The fungus affords new and local materials for instructional purposes in place of the temperate-climate fungus *Puccinia graminis tritici* and its hosts *Triticum* spp. and *Berberis vulgaris* all of which are unfamiliar to our students. Although the Philippine fungus has not been studied as extensively as *P. graminis tritici*, the general situation of heteroecism of rusts may be explained to our students using examples which they can obtain in abundance from hosts familiar to them.

RUST OF BANANA

On November 11, 1932 several banana plants (*Musa sapientum* L.), variety Halipo which grow in a semi-wild state along the north bank of the Molawin Creek below the Old College Building of the College of Agriculture were found to be heavily infected with the rust fungus on the leaves. The disease was serious both on the leaves of young suckers and of plants about to flower. The older leaves were especially seriously infected with the rust. Judging from the severity of the disease and its effects upon the banana some of the badly diseased plants would either fail to fruit or die prematurely on account of the rapid drying of the leaves.

---

[1] Experiment Station contribution No. 1019. Received for publication December 20, 1934.

Symptoms and signs of the banana rust

Rust infection of banana leaves is evident on the nether surface of the foliage. The lesions appear as brown to dark brown, elongate, slightly raised or rough blister-like lesions. Old lesions have pale or almost white strands on the surface. These whitish structures are especially abundant during cool weather.

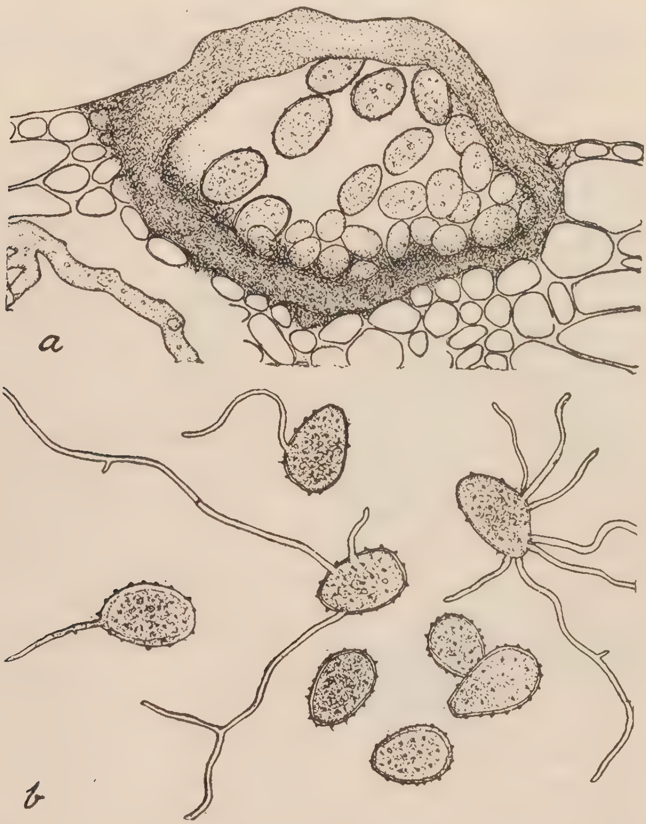


Fig. 1 (*a*).—Camera lucida drawing by M. S. Celino of a cross section of the sorus of the banana rust caused by *Uromyces musae* P. Henn. About 316 ×. (*b*) Camera lucida drawing of urediniospores both at rest and at germination. About 316 ×.

The lesions may appear singly as small dark brown elevated spots on the lower surface of the leaves. Generally, however, many spots appear in rows about 10 to 12 millimeters long and these rows are usually arranged parallel with the veins of the leaves. Heavily infected leaves show some of the fungous growth on the upper surface also. In advanced stages of the disease the tissues of the leaf around

the sori die and later larger and conspicuous portions of the leaves dry out. Finally, the death of entire expanded portions of the leaves follows.

The sori are not present on the midrib and petioles of the leaves of banana but only on the lamina.

The causal organism

A specimen of the rust of banana was sent to Professor S. F. Ashby of the Imperial Mycological Institute at Kew, England. Professor Ashby identified the fungus as *Uromyces musae* P. Henn.

On the Philippine material the uredinium (fig. 1a) of the fungus is produced sub-epidermally. Later, the epidermis breaks open and gives way to the sori. Before they break open the uredinia are almost spherical and measure from 126 to 239.4 μ in diameter with an average of 177.4 μ.

The urediniospores (fig. 1b) are borne on short pedicels. They are yellowish and spiny and vary in shape from nearly spherical, ovoid to elliptic or sometimes nearly kidney shaped. They are 25.2-42.1 $\times$ 21.0-29.4 μ; the average size being 34.8 $\times$ 24.6 μ.

The urediniospores germinate readily on agar blocks and produce from one to several germ tubes (fig. 1b). The germ tubes arise usually from the sides of the spores. Of the 150 germinating urediniospores examined, 10.67 per cent gave rise to germ tubes from the apex, 70 per cent from the sides and 19.33 per cent from both the apex and the sides of the urediniospores.

Besides urediniospores, no other spores have been found on the banana specimens collected and examined.

RUST OF EGGPLANT

In February, 1934 specimens of leaves of eggplant (*Solanum melongena* L.) bearing both pycnia and aecia of a rust were received by the writer together with a request for suggestions for the control of the disease. The specimens came from Mr. Alfonso T. Asuncion of the Zambales Rural High School at San Marcelino, Zambales Province. According to Mr. Asuncion this rust was very serious in their garden. A newly opened lot several hundred meters from their garden, although planted to the same variety of eggplant was, however, entirely free from the rust.

Mr. Asuncion further informed us that the eggplants are infected very seriously when they are about ready to flower. Younger plants may also be attacked but the disease becomes conspicuous when the

plants are about to bloom. Seriously infected plants are much stunted in their development but they seldom die from the infection. As the leaves grow older the lesions on them become more conspicuous and abundant than those on the upper younger leaves. The fungus, however, does not infect the fruits.

Symptoms and signs of the rust of eggplant

The infection of the eggplant with the rust is confined to the leaves. There are no conspicuous changes on the shape and size of the leaves infected with the disease.

Fig. 2.—Leaves of eggplant from San Marcelino, Zambales showing infection by a rust fungus. At the left (*a*) is a nether surface view of an infected leaf showing circular pale areas varying from five to ten millimeters in diameter. At the center of these pale areas the orange colored clusters of aecium cups are present. On the photograph the clusters of aecium cups form dark colored centers of the pale areas. At the right (*b*) is an upper surface view of an infected eggplant leaf showing dark colored dots due to the orange color of the pycnia. The pycnia are covered with orange mucilage-like substance. Note that the pycnia are more abundant towards the base of the leaf and along the midvein. (Photograph by the Photographic Division, Department of Soils.)

Infected leaves show the rust pustules on both surfaces. On the leaves examined, a few had practically all pycnia while the rest had pycnia on the upper surface (fig. 2a) and aecia on the lower surface (fig. 2b).

On the upper surface of the leaves orange colored dots indicate the location of the pycnia (fig. 2a). In the specimens examined the pycnia were in greater abundance than the aecia. Furthermore, the pycnia seem to be more abundant towards the base of the leaves. The pycnia are readily noticeable because they are covered with orange-colored mucilage-like substance.

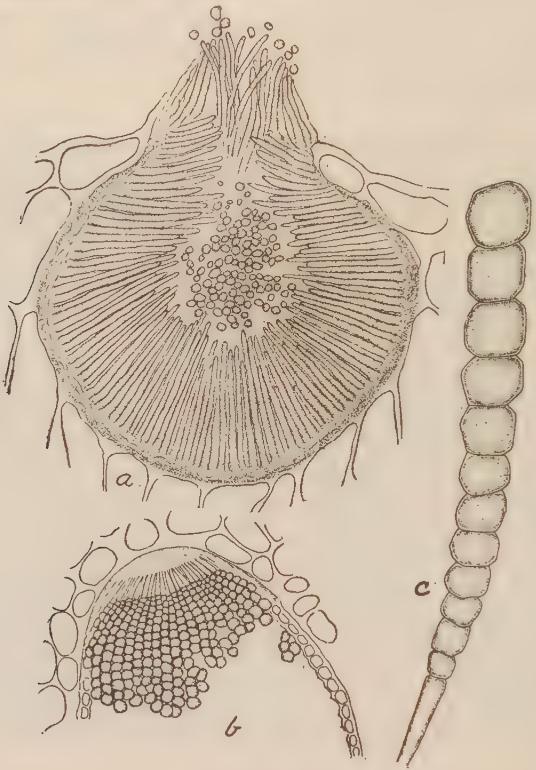


Fig. 3.—(*a*) A section through a pycnium of the rust of eggplant, *Solanum melongena* Linn. showing pycniospores. About 260 ×. (*b*) An aecium cup showing the arrangement of the chains of aeciospores on short stalks. About 96 ×. (*c*) A chain of aeciospores on the short stalk much enlarged. About 258 ×. Drawn from free-hand sections by Leopoldo Alicbusan.

The causal organism

Dried specimens of infected eggplant leaves were sent to Professor J. C. Arthur of Purdue University, Lafayette, Indiana, for determination. According to Professor Arthur the aecia on the eggplant belong to *Puccinia tubulosa* (P. and G.) Arth. This rust oc-

curs all over the world and it has its "telia on various species of *Paspalum* and *Syntherisma* (*Digitaria*)." Professor Arthur also states that "the aecia have been found on eggplants in Africa, but not before reported from the Philippines." Professor Arthur further states that Mrs. Clemens, who collected fungi from many places in the Philippines "gathered the uredia (of *Puccinia tubulosa*) on *Digitaria sanguinalis* near Rosales, Luzon in February, 1925 along fields and banks of Agno River."

The appearance of a pycnium of *Puccinia tubulosa* drawn free hand from sections is shown in figure 3a. The accium cup in a section is shown in figure 3b. A chain of acciospores, much enlarged, is shown in figure 3c.

As stated above both hosts of *Puccinia tubulosa* occur in the Philippines. Briefly, the life cycle of the fungus may be stated as follows: The eggplant receives infection from sporidia produced by the telia that are borne on *Digitaria sanguinalis* or other grass hosts. On the eggplant leaves the fungus produces pycnia and aecia. The aeciospores from the eggplant are carried over to grasses where they germinate, cause infection, and produce the uredia and telia.

The writer is indebted to Professor S. F. Ashby, Mycologist, Imperial Mycological Institute at Kew, England and Professor J. C. Arthur of the Department of Botany, Purdue University, Lafayette, Indiana, U. S. A. for determinations of the rusts reported in this paper.

1931

TOLERANCE OF MEALY BUGS TO DRYING OF HOST TISSUE [1]

LEOPOLDO B. UICHANCO
Of the Department of Entomology

J. N. R.

WITH TWO TEXT FIGURES

Among the troublesome pests of living cultivated plants in the Philippines, scale insects and mealy bugs occupy a prominent position. Their waxy exudates which form an efficient protection from rain, heat, drying, and, to some extent, from parasitic and predatory enemies, their high biotic potential, which is further augmented by parthenogenesis and ovoviviparity in many of the Philippine forms, their symbiotic relation with ubiquitous and aggressive ants, and the predominance of oligophagous, and even of polyphagous, habits in the group make these insects peculiarly well suited to the characteristic features of our tropical environment.

One other important adaptive attribute of at least some of the species of Coccidae that has been suspected (Uichanco and Villanueva, 1932)[2] but hitherto, so far as the writer is aware, never subjected to experimental test, is the ability to survive considerable drying in the host tissue. This feature is unusual in sucking insects, especially among those which, like the coccids, establish permanent attachment on the host, inasmuch as in other groups the members are generally too delicate to withstand any marked lessening in the moisture-content of the feeding media.

An opportunity was found to observe this peculiarity during the years 1931 and 1932, in connection with two species of mealy bugs, *Pseudococcus lilacinus* Cockerell, on yam, *Dioscorea alata* Linn., and *Trionymus sacchari* (Cockerell) on sugar cane.

Pseudococcus lilacinus. On January 16, 1931, a fleshy root of yam, collected by Mrs. L. B. Uichanco on the College Campus, at an elevation of 85 meters, was almost completely covered with *Pseudococcus*, so that the the white waxy coating could be seen from a dis-

---

[1] Experiment station contribution No. 1018. Read before the Los Baños Biological Club, October 25, 1934. Received for publication October 31, 1934.

[2] UICHANCO, LEOPOLDO B., AND FAUSTO E. VILLANUEVA. 1932. Biology of the pink mealy bug of sugar cane, *Trionymus sacchari* (Cockerell), in the Philippines. Philippine Agriculturist 21: 205–276. *Pl. 1–8; 14 charts.*

tance (fig. 1). The material was placed in our entomological laboratory for a museum specimen. After saving a part of the lot for permanent preservation, the rest was laid aside on a shelf and forgotten. Quite by accident, on rearranging the laboratory one year later, in January, 1932, it was noted that numerous first-instar nymphs were crawling restlessly among living adult mealy bugs on the surface of the wrinkled and nearly dried-up yam. The mealy bugs show distinctly in figure 2. The moisture-content of the one-year old host was determined in the Department of Agricultural Chemistry as averaging

Fig. 1.—Fresh yam infested by *Pseudoccus lilacinus* Cockerell, January 16, 1931.

15.68 per cent, which is exceedingly low, considering that that of a fresh yam is 69.33 per cent.

Fresh yam was secured on February 11, 1932, cut into two pieces, and each placed separately on a wide glass dish which was coated at the sides with tanglefoot, in order to keep ants and mealy-bug nymphs away. Into one lot was introduced a piece of the old yam that contained the mealy-bug colonies. The other lot was used as a check. By February 11, the day following, a few first-instar nymphs had settled on the fresh yam in the treated lot. There were many more three days later, especially on the cut ends and inside depressions formed by the protruding portions of the root skin. That the young

immigrants were not degenerate descendants of generations of famine-stricken parents on a dried host is shown by the fact that they carried on their complete life cycle, with the formation of ovisacs in most of the adults on March 29 and the production of the next brood of first-instar nymphs. It was originally planned that, as sufficient experience was gained with this preliminary work, another series consisting of more adequate replications should follow. Unfortunately, the material was prematurely destroyed by a common pest of stored products, the coffee weevil (*Araeocerus fasciculatus* De Geer

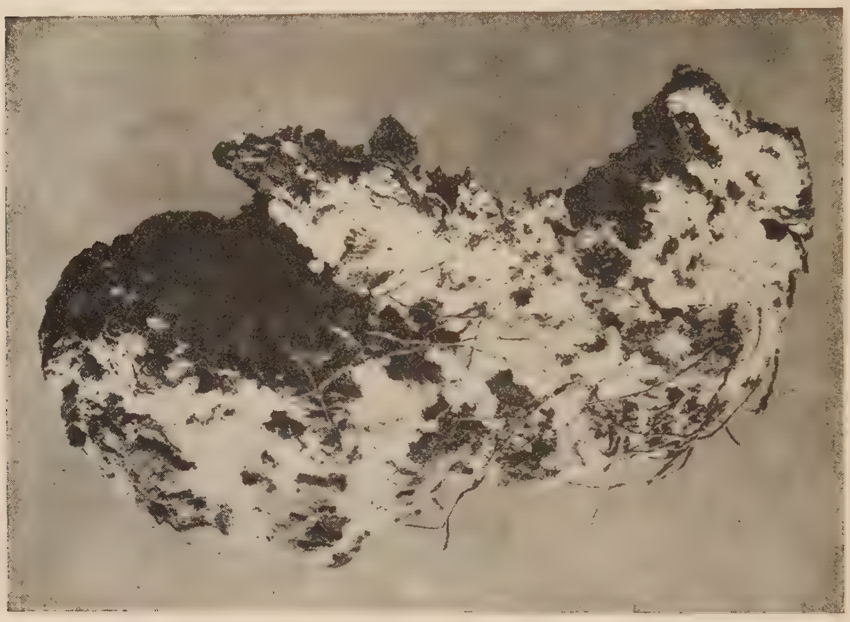


Fig. 2.—The same yam shown in fig. 1, in January, 1932, after one year in storage. Although considerably shrunken from drying, it was swarming with active nymphs of *Pseudococcus lilacinus*.

(Anthribidae), which made clean work of the dry starchy root, so that by August 12, 1932, no living mealy bug could be found. A species of ants, *Paratrechina* sp., was able to bridge over the tanglefoot barrier and aid the weevil in mutilating the root. Subsequent efforts to collect yam with mealy bugs from outside sources have so far failed.

With the control, however, remaining entirely free from mealy bugs during the period of observation, it would seem that enough evidence is on hand to warrant the conclusion that the mealy bugs

which appeared in the treated lot originated from the one-year-old yam and were not accidental contamination from the field.

Trionymus sacchari. Stem pieces of sugar cane, bearing colonies of the pink mealy bugs were gathered weekly or bi-weekly and stored on the cement floor in the laboratory.[3] The first lot was cut on February 16, 1932; the last, on February 7, 1933, covering a period of about one year. The stem pieces were inspected daily until no living mealy bugs could be noted. A summary of the results is as follows:

Mean duration (85 lots) from cutting of cane to death of all mealy bugs on stem	~~29.24~~ ± 0.88 days /49.24
Standard deviation	12.00 ± 0.62 days
Coefficient of variation	24.36 ± 1.26 per cent

The stem pieces on which the mealy bugs were found dead were dry to very dry. Because the life cycle in female *Trionymus* averages 39.21 ± 0.43 days (Uichanco and Villanueva, 1932), it is doubtful if this species can go through more than one brood on the cut cane, if the host is prevented from germinating, as was artificially done in the present experiments. Under field conditions, however, germination sets in ordinarily within a month's time; but should any untoward condition cause a delay, there is a safety margin of about 49 days, over which the mealy bugs can manage to live and produce their broods of young for dispersal to more favorable hosts.

The extraordinary resistance of certain coccids to adverse circumstances points to the necessity of exercising greater care in the preparation of the field for planting. Stubble, cut stems, left-over roots, and other material, unless carefully cleaned out and destroyed, are ideal stuff to carry the pests over between crops, especially in such species as *Pseudococcus lilacinus*, which is polyphagous.

Likewise, this unique biological feature is doubtless largely responsible for a considerable representation of coccid species among non-autochthonous Philippine agricultural pests. Indeed, a restudy of the subject of immigrant insect forms in the Philippines suggests the desirability for amplifying an earlier paper by the writer (Uichanco, 1926),[4] to include, among others, a large

---

[3] The writer is indebted to Mr. Victoriano J. Madrid, graduate student assistant in entomology, for help in securing sugar cane material and in observation.

[4] UICHANCO, LEOPOLDO B. 1926. Insects in relation to the introduced cultivated element of the Philippine flora. Proceedings Third Pan-Pacific Science Congress, Tokyo, p. 2069–2076. xix, 26

number of mealy bugs and scale insects. This angle of the problem incidentally opens important questions connected with plant quarantine.

SUMMARY AND CONCLUSIONS

Two species of mealy bugs are reported on: (1) *Pseudococcus lilacinus* Cockerell, which was able to produce successive broods for one year on stored yam, even with the host material shrunken to dryness in the last part of the year. (2) *Trionymus sacchari* (Cockerell) which lived on non-germinating cut stems for an average of 49.24 days.

The ability of certain coccid species to tide over dryness in host tissue presents peculiar problems in agricultural practice. This characteristic, moreover, apparently furnishes an explanation for the presence in the Philippines of many immigrant species of mealy bugs and scale insects.

BENEFICIAL EFFECTS ON DISEASED CACAO TREES OF REMOVING INFECTED PARTS AND DISINFECTING THE WOUNDS [1]

LEOPOLDO A. ALICBUSAN

WITH ONE PLATE AND THREE TEXT FIGURES

Cacao (*Theobroma cacao* L.) is one of the minor crops grown in the Philippine Islands which might be developed into an important crop. But at the present time for the most part cacao is grown only in back yards. Some large-scale plantings may be found, especially in the provinces of Cavite, Iloilo, Oriental Negros, Cebu, and Bohol (Bureau of Commerce and Industry, Statistical Handbook, 1932).

In addition to location of the plantation and climatic and soil requirements of cacao, there are several factors that should be considered in order to grow this crop with success and profit. Of these factors, diseases are important because they may limit the production of the tree, affect the quality of the crop and be a source of constant loss. Diseases of twigs and branches of the tree may result in a serious loss to the planter; the affected tree may die. The disease of the pods may infect the branches through the peduncles of the fruits and produce the same effect as the direct infection of the twigs and branches. If these diseases do not kill bearing trees they will reduce the yield considerably and in this way affect the income from cacao. Careless handling and neglect of cacao trees in the field favor the occurrence of diseases.

OBJECTS OF THE WORK

The objects of the work were (*a*) to determine what causes the death of branches, twigs, pods and seedlings of cacao, and (*b*) to determine the effects of removing the diseased parts and then disinfecting or dressing the wounds.

TIME AND PLACE OF THE WORK

The field experiments were carried out in the barrio of Maahas, Los Baños, Laguna, Philippine Islands. The laboratory work was conducted in the Department of Plant Pathology of the College of Agri-

[1] Thesis presented for graduation, 1934, with the degree of Bachelor of Agriculture from the College of Agriculture No. 442; Experiment Station contribution No. 1006. Prepared in the Department of Plant Pathology under the direction of Dr. G. O. Ocfemia.

culture at Los Baños. The work was started in August, 1932 and completed in March, 1934, thus covering a period of about 19 months.

MATERIALS AND METHODS

The materials for study used in this work were 78 diseased cacao trees already in bearing. In the treatments, coal tar, lead paint, Bordeaux paste, sapolin paint, 5 per cent solution of formalin, 5 per cent solution of copper sulfate were used. And the tools used were pruning and crescent-shaped saws, a pruning knife and paint brushes.

The cacao trees were all back yard plantings, hence, varied in age, size and general appearance. The trees were set at irregular distances and the soil and other conditions were not the same. The cacao plants had never been pruned.

Of the 78 trees used 66 were divided into six lots of 11 trees each. These lots I, II, III, IV, V and VI were treated. Twelve trees were used for the checks. The checks were divided into check 1 of 6 trees which were pruned but without painting the wounds, and check 2 of 6 trees which did not receive any pruning or treatment.

The trees were pruned on August 21, 1932. Before pruning, the trees were properly labeled, carefully examined and the condition of each tree was recorded.

The pruning was done with a pruning saw. The cut was made close enough to the main branches so that when the wounds healed the wood would be covered with the bark. The cut surfaces were made smooth so that they would not hold moisture and afford lodging places for fungous spores and bacteria. The prunings were taken to the laboratory of the Department of Plant Pathology and examined for rots and cankers and determination of the causes of these.

After pruning the trees in lots I, II, III, IV, V and VI, the wounds were treated each with a different material as follows:

Lot I, Bordeaux paste	Lot IV, formalin (5 per cent solution)
Lot II, lead paint	Lot V, $CuSO_4$ (5 per cent solution)
Lot III, coal tar	Lot VI, sapolin paint

The Bordeaux paste was prepared by slaking 1 kilogram of stone lime in 2.5 liters of tap water and dissolving 0.5 kilogram of copper sulfate or blue vitriol in 3.3 liters of hot water. The two solutions were mixed by pouring the copper sulfate solution into the lime solution and stirring vigorously.

In making the lead paint the following materials were used:

White lead	100 pounds
Raw linseed oil	2 gallons
Japan drier	1 pint
Turpentine	1 pint

The white lead was made sticky by the addition of a small amount of water. The oil was then added little by little to the paste with frequent stirrings. Japan drier and turpentine were added in the same way as the linseed oil.

The coal tar and sapolin paints which are commercially prepared and may be bought in any Chinese store in the locality were used undiluted.

The date of pruning and application of dressing materials on the wounds was recorded. Each tree was examined at monthly intervals. In each examination, observations were made on the following:

(1) Comparative vigor of treated and control plants.

(2) Production of new leaves and twigs and setting of fruit of the treated and control plants.

(3) Number of fruits on the treated and on the control trees.

To determine the cause of the death of a twig, a branch or a pod, isolations were made by the tissue-culture method. Small sections or cuttings of the diseased tissues, cut aseptically were plated out on sterile steamed corn meal in Petri dishes using a sterile sharp scalpel. Four sections from the inner part of the attacked portions were plated out in each Petri dish. After two or three days, transfers of small sections of the fungous growth from the Petri dish into the sterile potato-dextrose agar slants were made with a sterile wire hook.

To determine the relation of each of the fungi isolated, these organisms were tested in inoculation experiments. Fruits, twigs and branches of cacao were inoculated (*a*) by applying portions of the fungous growth on artificial media through slits made with a sterile scalpel; (*b*) by spraying the unwounded parts with spore suspension and (*c*) by placing bits of mycelium on the young buds of the cacao seedlings.

DISEASES OF PODS, TWIGS, BRANCHES AND SEEDLINGS

Symptoms.

On the pods. The pods attacked by the disease turn dark brown to almost black. In early stages of infection portions attacked are indicated by small spots either at the tip or butt portion of the pods. These spots increase rapidly in size and extend all over the surface of the pods. The disease destroys the rind and the seeds. In advanced stages of infection, mycelium bears an abundance of spores. The fungous growth appears as a downy mass (fig. 1) on the sur-

face and along the grooves of the pods. The diseased pods either fall to the ground or remain on the trunks and dry up and become mummified.

On branches and twigs. The twigs and branches are cankered. The dead parts are rough on the surface and the infected parts are depressed or shriveled up. The color of the diseased stem is dark brown, differing in color from the healthy branches and twigs. The disease encircles the branches or twigs.

Fig. 1.—A pod of cacao attacked by the black rot disease showing the thick downy growth of the causal fungus. Note that the middle groove is almost white on account of the mycelial growth of the fungus.

In the early stages of the disease the tissues underneath the bark present a reddish color which extends around the diseased stem. As the disease advances further the diseased parts become hard, depressed and rough. At this stage, yellowing and shedding of the leaves of the branch or twig take place (fig. 2).

On seedlings. On November 15, 1933, the writer examined the cacao seed beds of the Department of Agronomy of the College of Agriculture. In these beds the rapid dying of young cacao seedlings was noted. Infection started from the tip and gradually worked downwards killing the young and tender leaves of the seedlings (fig. 3). The infection extended as far as the woody portions of the stems. The infected parts became dry and hard.

ORGANISMS ISOLATED FROM DISEASED CACAO PODS, BRANCHES, TWIGS, AND SEEDLINGS

Diseases of cacao pods, twigs, and branches have been attributed to various fungi by different workers in different regions of the world. Reinking (1923) reported that *Phytophthora faberi* Maubl. causes black rot of the cacao pods in the Philippine Islands. He

also found that flowers, twigs and branches of cacao are attacked by the same fungus that causes blight of the flowers and canker of twigs and branches. Howard (1901) reported that the brown rot disease of the pods of cacao in the West Indies is caused by *Diplodia cacaoicola P. Henn.* Two other important pod diseases which cause considerable damage in Trinidad, British West Indies were reported in 1908 by J. H. Hart, Superintendent of the Royal Botanic Garden. One of the diseases is caused by *Phytophthora omnivora* de Bary and the other by *Nectria bainii* Massee. In 1910, Massee attributed the cacao pod blotch to *Nectria bainii.* Howard 1901) reported that *Diplodia cacaoicola* causes die-back of larger branches of cacao. According to van Hall (1914) canker of stem and branches of cacao caused by *Phytophthora faberi* Maubl. is widely spread in Trinidad, Surinam, Kamerun, Ceylon, Java and Samoa. According to Ghofulpo (1915) Johnson in 1912 stated that a species of *Lasiodiplodia* attacks fruits, stems and branches of cacao. Bancroft (1910) reported that *Nectria theobromae* causes canker of cacao. A brown bark rot of the cacao trunk in Los Baños, Laguna caused by *Hygomyces haematococcus* (B. and Br.) Wr. was reported by Ocfemia and Celino (1932).

Fig. 2.—The upper portions of the two main limbs of a cacao tree, showing at the upper left the bare dead tip, the result of canker. Note the bare and dead secondary branch (left) and the two dead fruits still attached to the main limb (right).

According to Doctor Ocfemia, Dr. C. J Humphrey, formerly Mycologist of the Philippine Bureau of Science, believed that the cause of die-back of twigs and branches and bark rot of cacao trees in the province of Batangas is a *Gloeosporium.*

Fungi isolated

In the writer's isolation experiments the following fungi were obtained:

(1) A species of *Phytophthora*, (2) a species of *Fusarium*, (3) a species of *Gloeosporium*, and (4) a species of *Diplodia* from the pod. Only *Phytophthora* was isolated from the dead branches and twigs. The isolations from blighted cacao seedlings also yielded only a *Phytophthora*.

Tests of pathogenicity

From the inoculation experiments the writer noted that only the *Phytophthora* culture consistently caused disease on the cacao pods, twigs, branches and cacao seedlings. The writer found that the cultures of the *Fusarium*, *Gloeosporium* and *Diplodia* which were isolated from cacao pods are not capable of causing infection. These organisms though consistently present on diseased cacao tissues were found to be saprophytic on the infected pods, branches and seedlings of cacao.

Identity of the pathogenic Phytophthora

In the study of the *Phytophthora* from the cacao pods, branches and seedlings (pl. I) the writer noted that the size of the conidia is very close to that given by Reinking (1923) for the coconut and cacao strains of *P. faberi*, while the size of the chlamydospores is closer to that of Ocfemia and Roldan (1927) and Tucker (1931) for the typical culture of *P. palmivora* Butl. (*P. faberi* Maubl.) than to that given by Reinking. The ratio of length to width is closer to that reported by Reinking than to that given by Rosenbaum (1917) or Ocfemia and Roldan (1927). The shape and form of the conidia, the prominence of the papilla, the method of germination, the ability to infect cacao plants and the cultural characters closely resemble those described by Reinking (1923) for the coconut and cacao strains of *Phytophthora faberi*. Ocfemia and Roldan (1927) attributed the cause of the discrepancy in the size of the conidia and chlamydospores of their *P. faberi* on citrus to differences in age and cultural conditions. Morphologically the *Phytophthora* isolated by the writer from diseased cacao pods, cankered twigs and branches and seedlings of cacao (pl. I) agrees to a remarkable degree with the *Phytophthora faberi* Maubl. described by Rosenbaum (1917), Reinking (1923), Ocfemia and Roldan (1927) and Tucker (1931.) Biologically, the writer's fungus agrees very closely with Reinking's (1923) cacao and coconut strains of *P. faberi*. The writer concludes that the *Phytoph-*

thora isolated from diseased pods of cacao and dead twigs, branches, and seedlings is *Phytophthora palmivora* Butler which is synonymous to *P. faberi* Maubl. The present work confirms earlier conclusions that the cause of black rot of pods, stem canker and seedling blight of cacao is the fungus *P. palmivora* Butler. This fungus not

Fig. 3.—Seedlings of cacao attacked by the same fungus that infects the pods and limbs The three seedlings represent three stages of the disease from leaf spot (left)to blight (right).

only infects cacao but also coconut, Para rubber, citrus, papaya and quinine.

EFFECTS OF REMOVING THE DISEASED PARTS AND DISINFECTING THE WOUNDS

Various workers on cacao diseases maintain that control may be effected in several ways. According to Ghofulpo (1915) Johnson

in 1912, reported that the attack on fruits, stems and branches of cacao by a certain species of *Lasiodiplodia* may be prevented by manuring and cultivation. This author further recommends the lopping-off of the diseased branches and stems and burning the excised portions. Tarring the ends of the stumps and spraying the pruned trees with a 3 per cent solution of copper sulfate are effective measures. According to Bancroft (1910) the canker of cacao may be controlled by removing the cankered parts and covering all the wounds with tar and clay in the form of a thick paste. Massee (1910) reports that the spread of the cacao pod blotch disease may be prevented by collecting and burning all diseased pods. According to Ocfemia and Celino (1932) the brown bark rot of the cacao trunk may be controlled by sprays for other cacao diseases or by excision of infected portions and painting the wounds with disinfectants. Ghofulpo (1915) reports that the ravages of fungous and insect enemies of cacao can be prevented by spraying the trees with Bordeaux mixture. He recommends pruning out the diseased parts, fertilizing the tree, etc., in combating diseases of cacao trees.

Results of wound treatments

The trees in lot I which were treated with Bordeaux paste produced the most pods on each tree and the trees in lot II which were treated with lead paint came next. The actual number of pods on each tree gradually decreased in lot III, lot IV, lot V, and lot VI in in the order given. The trees in lot III were treated with coal tar, lot IV with 5 per cent solution of formalin, lot V with 5 per cent solution of copper sulfate, and lot VI with sapolin paint. The trees which were used as check or pruned without painting the wounds produced more pods than the trees in lot III, lot IV, lot V, or lot VI. Trees used as check 2 or those that did not receive any pruning and treatment at all produced the least number of pods.

The production of new leaves and twigs appeared best in trees in lots I and II and in check 1. Fruit setting also seemed best in trees in lots I and II. In addition to the effect of the treatments on cacao trees, perhaps the differences in the total number of pods produced, production of new leaves and twigs, fruit setting and general condition of the tree, may also be attributed to better drainage and shade in lots I and II than in the other lots.

Conclusions from experiments on pruning and disinfection

Judged from their appearance before the experiments were begun and at the conclusion it may be stated that: (1) trees treated

with Bordeaux paste appeared more vigorous than the check trees and trees that received other dressings on the wounds after pruning. (2) Lead paint produced almost the same effect as Bordeaux paste. (3) Trees treated with coal tar, formalin solution, copper sulfate solution, and sapolin paint showed almost the same effect. They appeared to be nearly the same as check 1 trees though better than check 2 trees. (4) Trees in lots I, II and check 1 produced an abundance of new leaves and twigs while trees in the other lots of cacao trees produced fewer new leaves and twigs. (5) Fruits were produced in abundance by trees in lots I and II.

As stated above, the effects on the cacao trees and their diseases of the various dressings used after pruning were judged solely from the appearance of the plants. The reason for this was that the trees were all back yard plantings and they were set without attention to spaces between plants, shade, etc. The trees had never been pruned. They were of different ages and state of vigor.

SUMMARY

1. Diseases of cacao form one of the factors that limit cacao production.

2. Of the diseases of cacao the most injurious on the pods is black rot, on the twigs and branches, the canker, and on the seedlings, the blight. These diseases are caused by the fungus *Phytophthora palmivora* Butl. (= *P. faberi* Maubl.).

3. *Diplodia*, *Fusarium*, and *Gloeosporium*, though frequently associated with the cacao-pod disease were found to be saprophytic on pods. Probably these fungi grow after the pods have been attacked and killed by the black-rot disease.

4. Infection of cacao pods takes place either through wounds or by direct penetration of the fungus. Cacao seedlings may be blighted though there may not be any injury on them. Twigs and branches are infected only through wounds, possibly those caused by insects and mechanical agencies.

5. Cacao trees from which the dead pods are carefully removed and the diseased twigs are pruned off and the wounds treated with Bordeaux paste and lead paint appear more vigorous than trees treated with coal tar, formalin solution, copper sulfate solution, and sapolin paint.

6. Trees treated with Bordeaux paste and lead paint and those pruned without dressing the wounds produced an abundance of new leaves and twigs.

7. Well developed fruit setting and a large number of fruits were produced by trees treated with Bordeaux paste anu lead paint.

LITERATURE CITED

BANCROFT, K. 1910. *Nectria theobromae* Massee (canker of cacao). Handbook Fungus Dieases of West Indies Plants 23: 13–23.

GHOFULPO, T. G. 1915. Cacao and its local diseases. The Philippine Agriculturist and Forester 4: 162-173.

HOWARD, A. 1901. The fungoid disease of cacao in the West Indies. West Indian Bull. 2: 190–211.

MASSEE, G. 1910. Diseases of cultvated plants and trees. xii + 602 p., New York: The Macmillian Company, Ltd.

OCFEMIA, G. O., AND E. F. ROLDAN. 1927. *Phytophthora* blight of citrus.. American Jour. Bot. 14: 1–15. *Pl. 1–2.*

OCFEMIA, G. O., AND M. S. CELINO. 1932. A brown bark rot of cacao trunk. The Philippine Agriculturist 21: 665–673. *Pl. 1; fig. 1–2.*

REINKING, O. A. 1923. Comparative study of *Phytophthora faberi* on coconut and cacao in the Philippine Islands. Jour. Agric. Res. 25: 267–284. *Pl. 1–12; fig. 1–5.*

ROSENBAUM, J. 1917. Studies of the genus *Phytophthora.* Jour. Agric. Res. 8: 233–273. *Pl. 71–77; fig. 1–13.*

TUCKER, C. M. 1931. Taxonomy of the genus *Phytophthora* de Bary. Missouri Agric. Exper. Sta. Bull. 153: 1–208. *Fig. 1–28.*

VAN HALL, C. J. J. 1914. Cocoa. xvi + 515 p., 140 fig. New York: The Macmillian Company.

EXPLANATION OF PLATE I

Camera lucida drawings made by the writer, using Bausch and Lomb 10 × ocular and 4-mm. objective.

Fig. 1. Aërial mycelium of *Phytophthora faberi* Maubl. on the pod of cacao (*Theobroma cacao* L.) produced on oatmeal agar showing continuous and branched filaments. × 580.

Fig. 2. Submerged mycelium on oatmeal agar showing its irregular outline and frequent branching. × 580.

Fig. 3. A group of conidia and a portion of conidiophores, showing the characteristic shape of the spores and prominence of the papillae. × 580.

Fig. 4. A cluster of chlamydospores produced on oatmeal agar. × 580.

Fig. 5. Chlamydospores germinating by the production of germ tubes. A chlamydospore is shown with conidia and another chlamydospore at the end of the germ tubes. × 580.

Fig. 6. Conidia germinating by the production of germ tubes. A conidium is shown with a chlamydospore at the end of the germ tube. × 580.

Fig. 7. Differentiated zoöspores before they are liberated from the conidium, resting and motile zoöspores after their issuance from the conidium and germinating zoöspores. × 580. This type of germination was produced in hanging drops of water in Van Tieghem cells.

SODIUM ARSENITE VERSUS AEGINETIA INDICA [1]

G. O. OCFEMIA
Of the Department of Plant Pathology

On January 9, 1935 the writer's attention was directed by Dr. Leopoldo B. Uichanco, Head, Department of Entomology of the College of Agriculture at Los Baños to an item in the supplement of *Science* for December 7, 1934 which reads as follows:

> Certain perennial weeds can be made to "drink" poison through their tops. This recent finding is being taken advantage of by the California State Department of Agriculture in the eradication of the noxious weed known as camel thorn. Brought into the state from southwestern Asia, apparently in alfalfa seed, the weed has caused alarm because it does not respond successfully to ordinary methods of control. Under the direction of W. S. Ball, chief botanist, the tops of old plants are bent over and placed in quart or pint jars filled with a weak solution of arsenic, care being taken not to break the stems. The poison is carried into the root system by capillary action. Death follows not only for the plant treated but also for others growing from the same root system. Every few days the jars are filled with fresh poison and moved to other plants. The solution used is a one per cent strength of sodium arsenite or some other arsenical that is readily soluble in water. Farmers who have used the treatment experimentally against field bindweed, or wild morning-glory, report good results in the late summer when vines are mature. Care must be taken to keep grazing stock away from treated plants.

This item suggested to the writer the possible use of sodium arsenite for killing *Aeginetia indica* without seriously injuring the sugar cane roots to which this phanerogamic parasite is in intimate and biological union.

As young and vigorously growing *Aeginetia indica* on potted sugar cane plants was available the writer, assisted by Martin S. Celino of the Department of Plant Pathology, immediately tested the application of sodium arsenite:

(1) In the form of one per cent aqueous solution applied through the tops of flower stalks of the parasite by bending them and inserting each of the flower buds and the stalk in a test tube filled from one-half to two-thirds full of the solution of the herbicide;

---

[1] Experiment Station contribution No. 1021. Received for publication February 6, 1935.

(2) In the form of one per cent aqueous solution poured over the young growing *Aeginetia indica* at the rate of 50 cc. to the stool of the parasite;

(3) In the form of dry powder at the rate of ten grams applied around the bases of the flower stalks of the parasite, and then covering the stalks with soil; and

(4) In the form of dry powder applied at the rate of one gram to each hill of young emerging *Aeiginetia indica.* To simulate application by broadcasting of small amounts over a field of young canes, the powder was mixed with a small amount of soil, and the soil so treated was spread around the emerging flower stalk of *Aeiginetia indica.*

In these very limited preliminary tests with sodium arsenite on *Aeginetia indica* on potted canes very encouraging results were obtained. It took from two to seven days to kill the parasite by allowing it to "drink" the herbicide in the form of one per cent aqueous solution and three to six days when the same strength of the solution was poured over the parasite and the soil around it.

In the form of powder and applied at the rate of ten grams to each hill of the newly emerged parasite it took only one day to kill *Aeginetia indica.* The dose was apparently too strong and it caused serious injury in the form of wilting and blight of the young parasitized canes. Owing, however, to ability of the larger and faster growing canes to produce new roots to replace those that died from the toxic action of sodium arsenite, recovery of the larger canes followed.

In the dry form and applied by mixing it with a little soil and spreading the mixture over the emerging parasites, at the rate of one gram to each hill, it took from three to five days for the salt to kill *Aeginetia indica.*

The forms in which sodium arsenite may be used advantageously and the proportion for the control of *Aeginetia indica* in cane fields, the after effects upon the soil of the application of sodium arsenite in larger doses and the possible use of the chemical for weed eradication along fences and borders of farms are the objects of experiments in pots and plots now in progress and conducted by the writer and Martin S. Celino in the Department of Plant Pathology of the College of Agriculture.

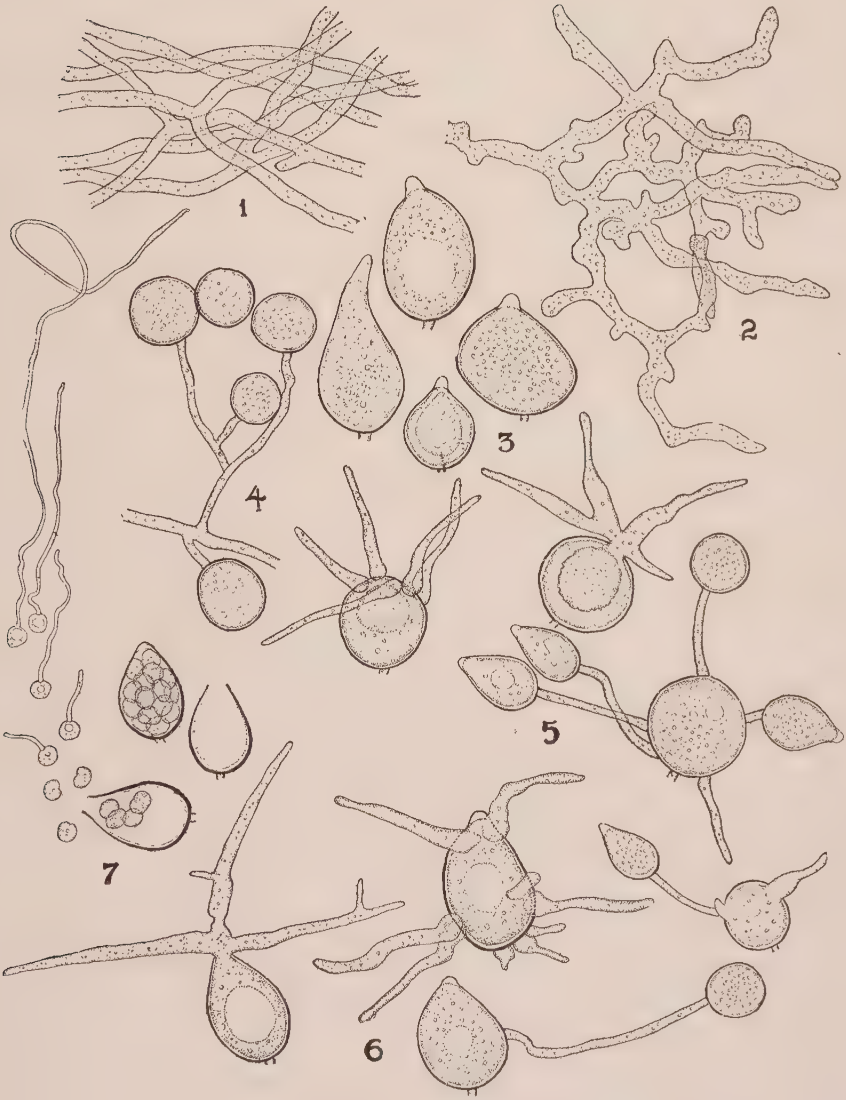


PLATE I

NOTE: PROFESSOR REGINALD H. KING[1]

Early in June, 1928, when the writer returned from an official trip to Japan, he was informed by Dean Gonzalez, that the Division of Sugar Technology of the Department of Agricultural Chemistry had been left without a professor in charge. Further, that he had been unable to secure the services of a local sugar technologist, especially a Filipino, with the maximum salary the University could offer. The Dean even went to the extent of personally interviewing these technologists in their offices in Luzon and the Visayan islands. Consequently, to carry on the course it became necessary to get a man from abroad. With the coöperation of Mr. H. Atherton Lee, former Director of Research of the Philippine Sugar Association, the services of Mr. Reginald H. King, then working with the Hawaiian Sugar Planters' Association, was secured for a period of three years at a salary of ₱6000 per annum. At that time this was a very modest remuneration.

In view of the high recompense then demanded by local sugar men for their services the writer was unable to feel enthusiastic about the new appointment. Generally, high class services call for high pay. Compared with the salaries then prevailing in the Sugar Industry, it was felt that a foreigner of merit would demand a higher salary than ₱6000. So, the appointment was just considered as the best that could be secured under the circumstances.

It did not take long, however, after Professor King's arrival for the writer to realize that the appointment was a very fortunate and happy one. He proved not only thoroughly conversant with the general principles of Sugar Technology, but he learned local conditions quickly. His spirit of coöperation was of the highest order. We, in turn, felt that he should be given an expert's salary and so at the first opportunity a recommendation was made to that effect.

Professor King came to us ready to work under conditions poorer than he found them, bringing with him a complete assortment of apparatus which he felt he would need in his work. At first, he underestimated the preparation and ability of his students but he adjusted his teaching as he discovered this. When he knew

[1] General contribution from the College of Agriculture No. 473.

his students better, he found no difficulty in raising his teaching to the desired standard.

Although Professor King came from a well equipped laboratory, the shortage of apparatus in the department did not dishearten him in the least. He patiently worked with the tools available and at the same time did his best to get new or better ones. He realized that the funds of the College were limited and therefore kept his eyes open for second hand but good equipment that might be had for the asking or at a nominal price. In this way he secured several engines from the Bureau of Public Works and a good boiler from the U. S. Army. The U. P. Sugar Mill is now almost completely equipped. Professor King was liberal with his own funds but not with the funds of the government.

A gem always shines. So after a short time, the Philippine Sugar Industry learned that a King was working in the College of Agriculture. Several attempts, some financially very tempting, were made to get him, but Professor King decided to stay and carry on his program of work until Dr. Getulio Guanzon, the man he helped select to receive training abroad should have returned and should have qualified to succeed him in the position. At the end of the three-year period he graciously declined an offer of a recommendation for a permanent appointment on the grounds that since he had no intention of becoming "native" his place should be filled by a local man as soon as practicable. Then later in 1933, when to effect economy, it was necessary for the University to retire personnel, he volunteered to be retired so that several junior members might be retained. The work could be carried on as Dr. Getulio Guanzon had been back for over a year.

Between teaching and coaching students in their research work, Professor King had only very limited time available to do research work. But as writing could be done even at home, he was able to publish many papers (some in collaboration with his students) in scientific and technical journals. He knows how to work not only with his head but also with his hands. In the running of the mill, he always worked with the students and laborers. For five and a half years, he was always on active duty—except for 24 days vacation leave, and 13 of these were taken just before he left in January, 1934 for China to take up his present work as Sugar Technologist, Provincial Government of Kwangtung, South China.

Professor King was a very able and inspiring teacher. His enthusiasm for the Sugar Technology profession was very contagious, hence the course became very popular.

His interest in his students did not end in the classroom. Even after a student had graduated Professor King was always ready to help him. To students who for one reason or another were unable to continue in the College he always gave a helping hand; those who wanted work he aided in getting it. For this quality the writer jokingly named him "Employment Bureau", and a very efficient bureau at that. How he worried when a student failed in his course!

While with us Professor King also served as Associate Editor of the Sugar News, and as member of the Committee of Experts in the determination of mill capacities for sugar limitation plans.

As a teacher and colleague, Professor King set a course which his successor need not hesitate to follow.

F. O. SANTOS
Head, Department of Agricultural Chemistry

PUBLISHED CONTRIBUTIONS OF THE COLLEGE OF AGRICULTURE: XII [1]

B. M. GONZALEZ
Dean, College of Agriculture

With the impending organization of the Philippine Commonwealth the country will be making its initial bid for national recognition. I do not know that there are any written or set standards that a country must meet before it is admitted into the family of nations, but every political unit finds soon enough that it must keep up with world progress if it is to hold its own in the concourse of nations. The world is more highly competitive than ever, with efficiency largely replacing arms as a weapon of struggle. A measure of efficiency may be gained by care and by constant repetition and practice in the performance of a task or process; this is very essential, but not fundamental. In the search for new methods, for better and cheaper ways of accomplishing a task, for new and better products, new materials, new uses, for greater economy in the use of materials, for improving the strength, durability and beauty of materials used, for a greater supply of necessities, we have to rely on systematic experimentation and research. While research is important in all lines of human endeavor, in the field of agriculture in the Philippines, our largest and most basic industry, it is doubly so, for on this one industry largely depends our material well-being as individuals and as a nation. Without it, all other industries, which are largely derivative of it or dependent on it, will languish.

The College of Agriculture makes a bid for better recognition and greater support in its allotted task of constantly endeavoring to improve the status of Philippine agriculture through the search for new knowledge. The annual list of published contributions herewith presented is the best guarantee the College can offer for its being alive to its responsibilities and as its steady valuable contribution in maintaining the life and stability of the coming Philippine Commonwealth.

II. EXPERIMENT STATION CONTRIBUTIONS

The contributions are numbered serially as reported. For Nos. 1–199, *see* THE PHILIPPINE AGRICULTURIST XII, No. 7, 1923. For

[1] General contribution from the College of Agriculture No. 477.

Nos. 200–287, *see* THE PHILIPPINE AGRICULTURIST XIII, No. 10, March, 1925. For Nos. 288–354, *see* THE PHILIPPINE AGRICULTURIST XIV, No. 10, March, 1926. For Nos. 355–440, *see* THE PHILIPPINE AGRICULTURIST XV, No. 10, March, 1927. For Nos. 441–517, *see* THE PHILIPPINE AGRICULTURIST XVI, No. 10, March, 1928. For Nos. 518–595, *see* THE PHILIPPINE AGRICULTURIST XVII, No. 10, March, 1929. For Nos. 596–643, *see* THE PHILIPPINE AGRICULTURIST XIX No. 2, July, 1930. For Nos. 644–710, *see* THE PHILIPPINE AGRICULTURIST XIX, No. 10, March, 1931. For Nos. 711–799, *see* THE PHILIPPINE AGRICULTURIST XX, No. 10, March, 1932. For Nos. 800–880 *see* THE PHILIPPINE AGRICULTURIST XXI, No. 10, March, 1933. For Nos. 881–948 *see* THE PHILIPPINE AGRICULTURIST XXII, No. 10, March, 1934.

(949) PENDLETON, ROBERT L. 1933. Notes on the geology of Leichow Peninsula, Kwantung. Geological Society of China Bulletin Vol. 12, No. 4:505–512. *2 pl.; 1 map.*

(950) KING, R. H., AND FERNANDO S. TORRES. 1934. On the recovery of sucrose from the last mill juice. Sugar News **15**: 78–82. *Fig. 1–2.*

(951) DE LEON, ANTONIO I., AND BRAULIO A. ALFARO. 1934. Some Philippine chicle gum substitutes. University of the Philippines Natural and Applied Science Bulletin **4**: 43–59.

(952) PENDLETON, ROBERT L. 1934. Philippine experience in reforestation with ipil-ipil (*Leucaena glauca*) and its application to conditions in Kwantung Province, China. Lingnan Science Journal **13**: 211–233. *9 plates.*

(953) OCFEMIA, G. O. 1934. Bud rot of coconut. The Philippine Agriculturist **23**: 4–10. *Fig. 1–2.* (*See* Circular 2.)

(954) JULIANO, JOSÉ B. 1934. Studies on the morphology of the Meliaceæ: I. *Sandoricum koetjape* (Burm. f.) Merrill. The Philippine Agriculturist **23**: 11–48. *Pl. 1–6; fig. 1.*

(955) CHAN, GREGORIO S., AND JUSTIANO D. GUIYAB. 1934. Comparative studies of the value of corn and palay as feed for chickens. The Philippine Agriculturist **23**: 49–72.

(956) FIGUEROA, WENCESLAO S. 1934. Comparative digestibility in vitro of Philippine bananas. *Abstract in* The Philippine Agriculturist **23**: 73.

(957) OCFEMIA, G. O. 1933. The transmission of the Fiji disease of sugar cane by an insect vector. University of the Philippines Natural and Applied Science Bulletin **3**: 277–280.

(958) VILLEGAS, VALENTE. 1934. Training cattle and carabaos for work. The Philippine Agriculturist **23**: 88–97. *Fig. 1–6.* (*See* Circular No. 26.)

(959) CELINO, M. S. 1934. Blight of cinchona seedlings. The Philippine Agriculturist **23**: 111–130. *Pl. 1; fig. 1–6.*

(960) MERCADO, TORIBIO. 1934. Propagation of kapok by budding and grafting. The Philippine Agriculturist 23: 131–139. *Fig. 1–3.*

(961) FAJARDO, ABELARDO J. 1934. A study of peanut and *Indigofera hendecaphylla* Jacq. as forage crops. The Philippine Agriculturist 23: 140–153. *Fig. 1–2.*

(962) FABELLO, SEBASTIAN F. 1934. Propagation of certain species of *Artocarpus* by marcottage. *Abstract in* The Philippine Agriculturist 23: 162–163.

(963) OCFEMIA, G. O. 1934. Bunchy-top of abacá. The Philippine Agriculturist 23: 174–186. *Fig. 1–6.* (*See* Circular No. 27.)

(964) FRONDA, F. M., AND D. D. CLEMENTE. 1934. Studies on the physical qualities of the hen's egg: I. Observations on new-laid Los Baños Cantonese eggs. The Philippine Agriculturist 23: 187–196. *Fig. 1.*

(965) MADRID, VICTORIANO J. 1934. Biological studies on the cucurbit-leaf beetle, *Ceratia similis* (Oliver) (Chrysomelidae, Coleoptera); with special reference to control with arsenical insecticides. The Philippine Agriculturist 23: 197–225. *Fig. 1–2.*

(966) ISIDORO, FRANCISCO R. 1934. A study of the immediate effects of detasseling upon the yield of Calauan Yellow Flint corn planted ear-to-the-row, and by the ordinary method. The Philippine Agriculturist 23: 226–237.

(967) PAULICAN, CENON, R. 1934. A study of the effects of commercial fertilizers on garden crops. *Abstract in* The Philippine Agriculturist 23: 238–240.

(968) SANTOS, GREGORIO C. 1934. The transverse strength of structural bamboo. *Abstract in* The Philippine Agriculturist 23: 240–241.

(969) BORJA, VALERIANO A., AND RAFAEL B. ESPINO. 1934. A study on the effects upon sugar cane plants of different ages of temporarily withholding the supply of water from the culture. I. Sugar News 15: 715–722.

(970) PENDLETON, ROBERT L. 1934. Notes on some tea soils of China, Formosa and Japan. Lingnan Science Journal 13: 457–463. *Pl. 1–4.*

(971) JULIANO, JOSÉ B. 1934. Studies on the morphology of the Meliaceae: II. Sterility in santol, *Sandoricum koetjape* (Burm. f.) Merrill. The Philippine Agriculturist 23: 253–266. *Pl. 1–2; fig. 1.*

(972) BALTAZAR, EULALIO P. 1934. Cotton culture. The Philippine Agriculturist 23: 267–285. *Fig. 1–13.* (*See* Circular 28.)

(973) CAPILI, JUSTO P. 1934. Comparison of yields from Ramai variety of rice broadcast and transplanted. The Philippine Agriculturist 23: 286–294.

(974) SORIANO, MARIANO F. 1934. Influence of amount of fertilizer in soil on growth of rice plant and on composition of its leaves. The Philippine Agriculturist 23: 295–316. *Fig. 1–6.*

(975) DAWIS, VICENTE M. 1934. Acclimatization of Irish potato. *Abstract in* The Philippine Agriculturist 23: 317–318.

(976) JULIANO, JOSÉ B. 1934. Origin of embryos in the strawberry mango. The Philippine Journal of Science 54: 553–561. *Pl. 1–3.*

(977) Stevens, Frank Lincoln, and E. F. Roldan. 1934. The Philippine Melialineae. The Philippine Journal of Science 56:——.

(978) Velmonte, J. E., and E. P. Baltazar. 1934. Cotton as a secondary crop in sugar regions. Sugar News 15: 487–495.

(979) Mane, Andres M. 1934. Spawning and feeding habits of ayuñgin, *Mesopristes plumbea* (Kner), a common theraponid fish in Laguna de Bay. The Philippine Agriculturist 23: 502–515. *Charts 1–3.*

(980) Crisostomo, Felipe E. 1934. Chemical analysis of some important varieties of tobacco grown in the Philippines. The Philippine Agriculturist 23: 516–528.

(981) Fernandez, Cesar J. 1934. The relative value of tahup sa mais and rice bran in rations for egg production. The Philippine Agriculturist 32: 529–542.

(982) Alonzo, Celestino. 1934. A test of some green manure crops. The Philippine Agriculturist 23: 543–558.

(983) Canlas, Guillermo L. 1934. Study of second and third year selection of seedling sugar canes grown in 1928–1929 cane breeding season in the College of Agriculture. *Abstract in* The Philippine Agriculturist 23: 559.

(984) Santos, Francisco B. 1934. Culture of ubi, nami and tugue in different soils as intercrop with some permanent planting. *Abstract in* The Philippine Agriculturist 23: 560–561.

(985) Soliven, Florencio A. 1934. The proximate chemical composition of the seed and oil of Philippine oil-bearing seeds: I. *Pongamia pinnata* Merr. The Philippine Agriculturist 23: 576–587.

(986) Manresa, Miguel, and Nicomedes C. Reyes. 1934. Hematological studies on cattle: I. The hemoglobin, erythrocytes and leucocytes in different breeds of cattle in the College of Agriculture. The Philippine Agriculturist 23: 588–603.

(987) Madrid, Victoriano J. 1934. Treatment of seeds and plant cuttings with coal tar-kerosene emulsion as a protection against certain insects. The Philippine Agriculturist 23: 604–612.

(988) Mariano, Cornelio O. 1934. Effects of fertilizers on the growth and development of young lanzon plants (*Lansium domesticum* Correa). The Philippine Agriculturist 23: 613–638.

(989) Necesito, Monico. 1934. The effect of spacing and rate of seeding on the yield and amount of starch of arrowroot. *Abstract in* The Philippine Agriculturist 23: 639–640.

(990) Fronda, F. M., and Augusto E. Kabigting. 1935. Protein supplements in poultry rations: III. The optimum amount of shrimp meal to use as supplement in rations for growing chicks. The Philippine Agriculturist 23: 652–661. *Chart 1.*

(991) Catambay, Alejandro B., and Clemente E. Yango. 1935. Cost of harvesting cassava with animal drawn plow. The Philippine Agriculturist 23: 662–665.

(992) Soliven, Florencio A., and Isidro Villafuerte Jr. 1935. The proximate chemical composition of the seed and oil of Philippine oil-bearing seeds: II. *Sterculia foetida* Linn. The Philippine Agriculturist 23: 666–680. *Fig. 1.*

(993) SAN PEDRO, A. 1935. Preliminary studies on the marcottage of the avocado. The Philippine Agriculturist 23: 681–688. *Fig. 1–3.*

(994) ROCES, RAFAEL, JR. 1935. A comparative study of two methods of management for fattening cattle. The Philippine Agriculturist 23: 689–705. *Fig. 1–2.*

(995) CAMPO, JOSÉ H. 1935. Studies on the storage temperature requirements of the chico, *Achras zapota* Linn. The Philippine Agriculturist 23: 706–722. *Fig. 1; chart 1.*

(996) SADDUL, JOSÉ C. 1935. A statistical study of the relation of the breaking strength of seed cob to the yield of Philippine Native Yellow Flint corn. *Abstract in* The Philippine Agriculturist 23: 723.

(997) LEMONCITO, CORNELIO G. 1935. A comparison of the invertase and hydrochloric acid methods of inversion and also determinations of the per cent glucose in final molasses of two Philippine sugar centrals for one milling season. *Abstract in* The Philippine Agriculturist 23: 723–725.

(998) FLORES, SIMEON S. 1935. Sesamum culture as affected by seed selection. *Abstract in* The Philippine Agriculturist 23: 725–727.

(999) CRUZ, AURELIO O., AUGUSTUS P. WEST, AND VICENTE B. ARAGON. 1932. Composition of Philippine rice oil (Ramai variety). The Philippine Journal of Science 48: 5–12.

(1000) ESPINO, R. B., AND VALERIANO A. BORJA. 1935. A study on the effects upon sugar cane plants of different ages of temporarily withholding the supply of water from the culture. Sugar News 16: 45–52.

(1001) SANTOS, F. O., AND N. A. PIDLAOAN. 1934. The food of inmates of the Correctional Institution for Women. The Journal of the Philippine Islands Medical Association 14: No. 7: 252–258.

(1002) VILLANUEVA, LOEPOLDO J. 1933. Modified ammonia bulb. University of the Philippines Natural and Applied Science Bulletin 3: 451–452.

(1003) VILLEGAS, VALENTE. 1935. Seasonal yield and productive life of Guinea grass (*Panicum maximum* Jacq.) for soiling purposes. The Philippine Agriculturist 23: 742–748.

(1004) MANRESA, MIGUEL. 1935. Studies on surra: I. The outbreak of surra in 1933 in the College of Agriculture. The Philippines Agriculturist 23: 749–759.

(1005) BALTAZAR, EULALIO P., AND GRACIANO ESPINUEVA. 1935. The effect of different methods of planting on Batangas cotton. The Philippine Agriculturist 23: 759–778.

(1006) ALICBUSAN, LEOPOLDO A. 1935. Beneficial effects on diseased cacao trees of removing infected parts and disinfecting the wounds. The Philippine Agriculturist 23: 891–904. *Fig. 1–3; pl. 1.*

(1007) GARCIA, NICASIO M. 1935. Palay vs. corn as a constituent of rations for growing and fattening pigs. The Philippine Agriculturist 23: 779–788.

(1008) DAVID, RAFAEL T. 1935. A study of the salt requirements of the young sugar cane plant with special reference to its nitrogen requirements. The Philippine Agriculturist 23: 789–809. *Fig. 1–8.*

(1009) MAGNO, CEFERINO L. 1935. The effect of topping and suckering on the yield and quality of tobacco. *Abstract in* The Philippine Agriculturist **23**: 813–814.

(1010) DE LOS REYES, ARTURO. 1935. Storing corn on a large scale. *Abstract in* The Philippine Agriculturist **23**: 814–815.

(1011) CRUZ, A. O., A. P. WEST, AND N. B. MENDIOLA. 1932. Composition of Philippine rice oil (Hambas variety). Philippine Journal of Science **47**: 457-495.

(1012) CAPINPIN, JOSÉ M. 1933. Studies on the genetics and cytology of Triploid Oenotheras. Cytologia **4**: 355–426.

(1013) MERCADO, T. 1934. A new juice squeezer for pre-harvest analysis of sugar cane. Sugar News **15**: 1–5.

(1014) MENDIOLA, N. B. 1934. Cassava culture. The Stockman and Farmer **2**: 3–4, 23–24. (October).

(1015) MENDIOLA, N. B. 1035. Cassava starch manufacture. The Stockman and Farmer **2**: 15–17, 23. (January).

(1016) JULIANO, JOSÉ B. 1935. Morphology of the sweet potato (Linn.) Poir. The Philippine Agriculturist **23**: 833–858. *Pl. 1–3.*

(1017) MANRESA, MIGUEL, AND B. M. GONZALEZ. 1935. Studies on surra: Natural recovery from surra infection among oxen and water buffaloes. The Philippine Agriculturist **23**: 859–879.

(1018) UICHANCO, LEOPOLDO B. 1935. Tolerance of mealy bugs to drying of host tissue. The Philippine Agriculturist **23**: 886–890. *Fig. 1–2.*

(1019) OCFEMIA, G. O. 1935. Two rusts hitherto unreported on economic hosts from the Philippine Islands. The Philippine Agriculturist **23**: 880–885. *Fig. 1–3.*

(1020) ORTIZ, PONCIANO F. 1935. Determination of distance of planting of certain fruit trees. *Abstract in* The Philippine Agriculturist **23**: 920–921.

(1021) OCFEMIA, G. O. 1935. Sodium arsenite versus *Aeginetia indica.* The Philippine Agriculturist **23**: 905–906.

III. GENERAL CONTRIBUTIONS

The contributions are numbered serially as reported. For Nos. 1–104, *see* THE PHILIPPINE AGRICULTURIST XII, No. 7, December, 1923. For Nos. 105–141, *see* THE PHILIPPINE AGRICULTURIST XIII, No. 10, March, 1925. For Nos. 142–164, *see* THE PHILIPPINE AGRICULTURIST XIV, No. 10, March, 1926. For Nos. 165–184, *see* THE PHILIPPINE AGRICULTURIST XV, No. 10, March, 1927. For Nos. 185–203, *see* THE PHILIPPINE AGRICULTURIST XVI, No. 10, March, 1928. For Nos. 204–216, *see* THE PHILIPPINE AGRICULTURIST XVII, No. 10, March, 1929. For Nos. 217–266, *see* THE PHILIPPINE AGRICULTURIST XIX, No. 2, July, 1930. For Nos. 267–288, *see* THE PHILIPPINE AGRICULTURIST XIX, No. 10, March, 1931. For Nos. 289–308, *see* THE PHILIPPINE AGRICULTURIST XX, No. 10, March, 1932. For Nos.

308–348, *see* THE PHILIPPINE AGRICULTURIST XXI, No. 10, March, 1933. For Nos. 349–397, *see* THE PHILIPPINE AGRICULTURIST XXII, No. 10, March, 1934. (No. 398 omitted in the following list, *see* note, March, 1934)

(399) PENDLETON, ROBERT L. 1934. Wheel vehicles in Kwantung. Lingnan Science Journal 13: 177–186. *6 pl.*

(400) GONZALEZ, B. M. 1934. The National Research Council of the Philippine Islands. The Philippine Agriculturist 23: 1–3.

(401) YULE, EMMA S. 1934. A review: "Cato, the Censor on farming." The Philippine Agriculturist 23: 156–161.

(402) ESPINO, RAFAEL B. 1934. Give farming a new vigor. The Philippine Agriculturist 23: 85–87.

(403) SACAY, FRANCISCO B. 1934. A study of teachers of vocational agriculture in the Philippines. The Philippine Agriculturist 23: 98–110.

(404) PENDLETON, ROBERT L. 1934. Soil survey trends in Java. The American Soil Survey Association Bulletin 15: 73–75.

(405) ESPINO, RAFAEL B. 1934. Consultations on farm problems. Agricultural Life 1: 23–24.

(406) FRONDA, F. M. A factory for eggs; Why not? Philippines Free Press, July 14, 1934: p. 10–11.

(407) PENDLETON, ROBERT L. 1934. The Bicol Region: From the notebook of a soil technologist. The Philippine Agriculturist 23: 247–252.

(408) FRONDA, F. M. 1934. The hen and the housewife. The Dawn 1: 26.

(409) FRONDA, F. M. 1934. The Fifth Philippine Egg-Laying Contest. Agricultural Life 1: 12–13.

(410) FRONDA, F. M. 1934. Eggs and gold. The Dawn 1: 16–17.

(411) GONZALEZ, B. M. 1934. Our Silver Anniversary. The Philippine Agriculturist 23: 327–330. *Fig. 1.*

(412) SANTOS, F. O. 1934. Agricultural Chemistry in the service of the State. The Philippine Agriculturist 23: 337–349. *Fig. 1–2.*

(413) GUANZON, GETULIO A. 1934. The Division of Sugar Technology in the service of the Philippine sugar industry. The Philippine Agriculturist 23: 350–360. *Fig. 1.*

(414) TEODORO, A. L. 1934. Agricultural Engineering investigations in the past twenty-five years. The Philippine Agriculturist 23: 363–367. *Fig. 1–2.*

(415) SACAY, FRANCISCO M. 1934. The accomplishments of the Department of Agricultural Education. The Philippine Agriculturist 23: 368–370. *Fig. 1.*

(416) DAVID, PEDRO A. 1934. Some practical contributions of the Agronomy Department to Philippine crop production. The Philippine Agriculturist 23: 373–379. *Fig. 1–2.*

(417) GONZALEZ, L. G. 1934. Outstanding results of agronomic and horticultural research. The Philippine Agriculturist 23: 380–399. *Fig. 1–2.*

(418) ESPINO, RAFAEL B. 1934. A quarter century of research activity in the Department of Plant Physiology. The Philippine Agriculturist 23: 403–415. *Fig. 1–2.*

(419) UICHANCO, LEOPOLDO B. 1934. A twenty-five year balance sheet for economic entomology. The Philippine Agriculturist 23: 419–429. *Fig. 1–2.*

(420) MANRESA, MIGUEL. 1934. A quarter century of work on animal improvement. The Philippine Agriculturist 23: 433–443. *Fig. 1–2.*

(421) TALEON, ALEJO T. 1934. Contributions of the Department of Animal Husbandry to Philippine animal dietary. The Philippine Agriculturist 23: 444–456. *Fig. 1.*

(422) VELMONTE, JOSÉ E. 1934. Some aspects of Philippine rural economy. The Philippine Agriculturist 23: 459–463. *Fig. 1.*

(423) OCFEMIA, G. O. 1934. Our work on plant diseases. The Philippine Agriculturist 23: 467–476. *Fig. 1–2.*

(424) PENDLETON, ROBERT L. 1934. Our contribution to the knowledge of tropical soils. The Philippine Agriculturist 23: 479–485. *Fig. 1–2.*

(425) YULE, EMMA S. 1934. What and wherefore. The Philippine Agriculturist 23: 489-492.

(426) PENDLETON, ROBERT L. 1934. Soil science in China in 1933. Proceedings of the Fifth Pan-Pacific Science Congress. p. 581–584. Vancouver, B. C. June, 1933.

(427) GONZALEZ, B. M. 1934. Education among farmers' children. Sugar News 15: 474–476.

(428) MENDIOLA, N. B. 1934. Selected species, varieties and strains for starting our new crop industries. Sugar News 15: 481–482.

(429) PENDLETON, ROBERT L. 1934. Reginald Hart King. Sugar News 15: 600–604. *Fig. 1–9.*

(430) FRONDA, F. M., AND ENGRACIO BASIO. 1934. A new national champion. The Poultry Journal 3: 3, 4. (September).

(431) FRONDA, F. M. Helping the Filipino farmers by means of our Extension Service. The Philippine Collegian, October 10, 1934.

(432) FRONDA, F. M. How our College helps solve the problems of the farmer. The Philippine Collegian, October 10, 1934.

(433) COLE, ANNE F. Loyalties. The Philippine Collegian, October 10, 1934.

(434) YULE, EMMA S. Good environment—One of the boosting boasts of Los Baños. The Philippine Collegian, October 10, 1934.

(435) PENDLETON, ROBERT L. 1934. Our College theses—a stimulus to accomplishment. The Philippine Agriculturist 23: 495–501.

(436) GONZALEZ, B. M. 1934. The celebration on our Silver Anniversary. The Philippine Agriculturist 23: 571–575.

(437) GONZALEZ, B. M. 1934. The College of Agriculture. Agricultural Life 1, No. 8–9: 5, 8. *Fig. 1–3.*

(438) MENDIOLA, N. B. 1934. What to see on the Campus and Experimental Grounds of the College of Agriculture. Agricultural Life 1, No. 8-9: 9, 11. *Fig. 1.* (Also in Sugar News 15: 647–649 under the title, The Campus and experimental grounds of the College of Agriculture).

(439) SANTOS, F. O. 1934. Studies on Filipino nutrition in the College of Agriculture. Agricultural Life I, No. 8–9: 12, 14. *Fig. 1.*

(440) ESPINO, RAFAEL B. 1934. Crop production based on scientific research. Agricultural Life 1, No. 8–9: 16, 18. *Fig. 1.*

(441) OCFEMIA, G. O. 1934. Outstanding contributions of the College of Agriculture. Agricultural Life 1, No. 8–9: 18, 19.

(442) SACAY, F. M. 1934. The U. P. Rural High School. Agricultural Life 1, No. 8–9: 20, 22.

(443) YULE, EMMA S. 1934. Farm Scenes recalled as Christmas bells ring. Agricultural Life 1: 7, 26, 33.

(444) OCFEMIA, G. O. 1935. In memoriam: Frank Lincoln Stevens. The Philippine Agriculturist 23: 649–651. *Frontispiece.*

(445) PENDLETON, ROBERT L. 1935. Rubber forestry: What research might have meant to agriculture in the Philippines. Sugar News 16: 7–15. *Fig. 1–12.*

(446) SACAY, FRANCISCO M. 1932. Poultry raising in schools. Philippine Poultry Journal 1, No. 10:3.

(447) SACAY, FRANCISCO M. 1934. The place of agricultural readjustment. Agricultural Life 1: 17, 21.

(448) BUENAVENTURA, T. F. The economic significance of the Hare-Hawes-Cutting Act. The Philippines Herald, March, 1933. Also in "The Monday Mail, March, 1933.

(449) BUENAVENTURA, T. F. Materialism and the profit system. The Philippines Herald, June 2, 1934.

(450) BUENAVENTURA, T. F. The challenge of the depression. The Tribune, June 24, 1934.

(451) BUENAVENTURA, T. F. Lessons from history. The Tribune, July 8, 1934.

(452) BUENAVENTURA, T. F. Living to live. The Tribune, August 5, 1934.

(453) BUENAVENTURA, T. F. Life of plenty. The Tribune, September 9, 1934.

(454) BUENAVENTURA, T. F. Loyalty Day. The Tribune, October 7, 1934.

(455) BUENAVENTURA, T. F. Perennial poverty. The Tribune, November 11, 1934.

(456) BUENAVENTURA, T. F. The higher motive. The Tribune, December 9, 1934.

(457) BUENAVENTURA, T. F. Christianity. The Tribune, December 23, 1934.

(458) BUENAVENTURA, T. F. Loyalty—Its meaning, Philippine Collegian, October 10, 1934

(459) BALTAZAR, EULALIO P. A toast to the College of Agriculture on its Silver Anniversary. The Tribune, October 11, 1934.

(460) BALTAZAR, EULALIO P. Why the Filipinos should adopt English as their national language. The Tribune, October 28, 1934.

(461) BALTAZAR, EULALIO P. 1934. Cotton growing in the Philippines. The Stockman and Farmer 2, No. 2:

(462) PENDLETON, ROBERT L. 1935. Glimpses of Cotabato Province: From the notebook of a soil technologist. The Philippine Agriculturist 23: 733–741.

(463) ARAGON, V. B. 1934. Increase your rice yield. The Stockman and Farmer 1: 11, 22.

(464) ARAGON, V. B. 1934. How to grow soybeans. The Stockman and Farmer 2: 3–4, 24, 31.

(465) DAVID, PEDRO A. 1934. Soap making on the farm. The Stockman and Farmer 1: No. 6: 5–7, 24.

(466) DAVID, PEDRO A. Plant catch crops. The Stockman and Farmer 1: No. 10: 6–7, 33.

(467) MENDIOLA, N. B. 1934. Crop production as a business. The Stockman and Farmer 1: 3–5, 22.

(468) MENDIOLA, N. B. 1934. Saving our mangosteen production. College of Agriculture started trials of propagation by marcottage in Jolo. The Stockman and Farmer, 1: (September, No. 12): 3, 36.

(469) MENDIOLA, N. B. 1934. Selected species, varieties and strains for starting our new crop industries. The Philippines need an organized and systematic plant introduction work. Sugar News 15: 481–482.

(470) MENDIOLA, N. B. The College of Agriculture and new farm industries. The Herald Mid-week Magazine, October 3, 1934.

(471) MENDIOLA, N. B. Pressing needs of the College of Agriculture. The Philippine Collegian, October 10, 1934.

(472) PENDLETON, ROBERT L. 1935. Glimpses of hinterlands in the Southern Islands: Zamboanga, Jolo and Cebu. From the notebook of a soil technologist. The Philippine Agriculturist 23: 823–832.

(473) SANTOS, F. O. 1935. Note: Professor Reginald Hart King. The Philippine Agriculturist 23: 907–909.

(474) UICHANCO, LEOPOLDO B. A college founded on enthusiasm. The Philippine Collegian, October 10, 1934.

(475) UICHANCO, L. B. The place of the College of Agriculture in P. I. [economic life] life. The Philippines Herald, October 3, 1934. Midweek magazine p. 5 and 17.

(476) PENDLETON, ROBERT L. 1935. Photographic records of field trips, especially in the tropics. Lingan Science Journal 14: 123–128.

(477) GONZALEZ, B. M. 1935. Published contributions of the College of Agriculture: XII. The Philippine Agriculturist 23: 910–919.

IV. CIRCULARS

The circulars are numbered serially as reported. For Nos. 1–5, *see* THE PHILIPPINE AGRICULTURIST XIV, No. 10, March, 1926. For Nos. 6–11, *see* THE PHILIPPINE AGRICULTURIST XV, No. 10, March, 1927. For Nos. 12–14, *see* THE PHILIPPINE AGRICULTURIST XVI, No. 10 March 1928. For Nos. 15–16, *see* THE PHILIPPINE AGRICULTURIST XVII, No. 10, March, 1929. For Nos. 17–18, *see* THE PHILIPPINE AGRICULTURIST XIX, No. 2, July, 1930. For Nos. 19–21, *see* THE PHILIPPINE AGRICULTURIST XX, No. 10, March, 1932. For Nos. 22–24, *see* THE PHILIPPINE AGRICULTURIST XXI, No. 10, March, 1933. For No. 25 *see* THE PHILIPPINE AGRICULTURIST XXII, No. 10, March, 1934.

No. 26.—VILLEGAS, VALENTE. 1934. Training cattle and carabaos for work. (*See* Experiment Station contribution No. 958.)

No. 27.—OCFEMIA, G. O. 1934. Bunchy-top of abaca: Its nature and control. (*See* Experiment Station contribution No. 963.)

No. 28.—BALTAZAR, EULALIO P. 1934. Cotton culture. (*See* Experiment Station contribution No. 972.)

ABSTRACT[1]

Determination of distance of planting of certain fruit trees. PONCIANO F. ORTIZ. (*Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 447; Experiment Station contribution No. 1020.*) —The object of the investigation was to determine the distance of planting of 45 kinds of fruit trees under Los Baños conditions.

There were 19 different families of fruit trees used representing 27 genera and 45 species, totalling 866 fruit trees. Trees were in bearing age. Observations and measurements were made on trees that were available in the College of Agriculture and on some in nearby barrios.

Measurements included the height of the tree, diameter of the crown, girth of trunk, and length of lateral roots.

To determine relationship between size and age, 7 kinds of plants were used with a total of 147 specimens. They were anonas, balimbing, breadfruit, chico, lanzon, macopa, and duhat.

To determine the size of some fruit trees, 9 kinds of plants were used with a total of 163 trees. They were avocado, bignay, calamondin, camias, guanabano, guava, jakfruit, pummelo and santol.

For comparison as to close planting and wide planting 9 kinds of plants were used. They were the ates, avocado, bignay, chico, guanabano, lanzon, mango, pummelo and santol.

Results showed that the ratios of height, diameter, and girth increase were greater for young trees than for old trees of the same kind. The frequent ratio was 1:2 for young trees and 1:1 for old trees.

Fruit trees in the College were better as to symmetry of form with more regular and compact crown than those found in the barrios. In spite of poor drainage and shallow surface soil in the College orchard, the wider distance of planting and more modern cultural practices followed, more than offset the advantages of a much deeper soil in the barrios.

The soil fertility, moisture supply, and method of propagation used are the most important considerations in deciding planting dis-

[1] Abstract prepared as part of required theme work in English 3a, College of Agriculture.

tances. These are indicated by the size of the tree in the particular locality. Using the spread of the crown as a basis, a safe planting distance may be obtained.

Longevity of lateral roots may also be used as a means of determining distance of planting. Recommendations showed that the shortest distance for planting was 4 meters; this was for papaya (Hawaiian Round) and the longest was 15.5 meters which was for tamarind. Lateral roots of these two trees vary in length proportionally.

Some of the recommended planting distances were:

Chico, 12 meters; guanabano, 6.5 meters; anonas, 10.5 meters; bignay, 10.0 meters; breadfruit, 12.5 meters; jakfruit, 11.5 meters; pili, 9.5 meters; native papaya, 4.5 meters; Batangas mandarin, 8.0 meters, Carabao mango, 18.0 meters; and avocado, 11.5 meters.

—*Abstract by Raul Ruiz de Arána*

KERNELS

"CORN FROM THE SHEAVES OF SCIENCE"

The amount of feed needed by a hen in one year is: for a Cantonese, 30. kgm.; a White Leghorn, 33.9 kgm.; a Nagoya, 34.0 kgm.; a Mikawa, 36.0 kgm.; a Rhode Island Red, 40.4 kgm.

To produce one dozen eggs, a hen requires the following weight of feeds: a Cantonese, 2.1 kgm.; a White Leghorn, 2.2 kgm.; a Nagoya, 2.3 kgm.; a Mikawa, 2.3 kgm.; a Rhode Island Red, 2.5 kgm.

All the embryos of the strawberry mango, an Indian variety, arise from the nucellus. This variety is, therefore, not a suitable material for hybridization.

Sunning the eggs prior to placing them in the incubator and every three days thereafter will result in a significant increase in percentage of hatchability.

All seeds for planting should be taken from vigorous plants which are free from disease.

Different varieties of sugar cane differ in their susceptibility to eye-spot disease caused by *Helminthosporium sacchari* Butler.

The ring spot of sugar cane caused by *Leptosphaeria sacchari* Breda de Haan attacks different varieties of sugar cane with varying degrees of severity.

From the view point of economy in egg production, a poultry raiser should feed corn, if he can secure this grain at the same cost as palay, kilogram for kilogram; but if both corn and palay are abundant, the combination of the two grains will be better than to feed either one alone.

The dressing percentage among the different classes of Philippine animals is as follows: Native cattle, 40.5 per cent; Philippine native carabao 40.4 per cent; goats, 43.1 per cent; sheep, 40.0 per cent; Berkjala swine, 73.2 per cent.

The College of Agriculture owns a herd of 186 swine practically all of which are of the Berkjala breed.

There are 35 grade Anglo-Nubian goats and 15 Indian sheep in the College of Agriculture.

The per capita sugar consumption of fifty families in Calauan, Laguna was found to be 16.6 kilograms a year.

CURRENT NOTES

We might just as well command the sun to stand still as to say that science should take a holiday. Science has turned scarcity into plenty. Merely because it has served us well is no reason why we should charge science with the responsibility for our failure to apportion production to need and to distribute the fruits of plenty equitably. That failure we must charge squarely to organized society and to government. We need economic machinery corresponding to our scientific machinery in precision, in power and in delicacy of adjustment. Science has done the first job, and done it magnificently. It has shown us how to produce. Now it must show us how to distribute what we produce. It must go forward and not back. To production science we must add economic science, without for a moment ceasing to advance the former. Because we have surpluses of certain things does not mean that we have too much wealth or too much power to produce wealth. To suppose that we have is to imply that man would be better off without means to make nature do his will. HENRY A. WALLAU.

Science, August, 1934

During the summer vacation of 1933, the Lecturer in Natural and Agricultural Sciences, Mr. W. A. McD. Paterson, B. Sc., with the assistance of the Officers of the Department and others, conducted a very successful course of one fortnight's duration to 24 Headmasters of elementary schools.

The object of the course was to make the nature teaching in the schools a more real thing to the teachers, and it included such practical subjects as the propagation of fruit trees by various methods—also beekeeping.

Agricultural Journal (Barbados, W. I.), April, 1934.

An apple tree in the Ukraine is reported to have flowered for a fourth time this year, while fruits in all stages of ripeness hang on the tree from the second and third flowerings.

Science News Letter, November 10, 1934.

"I can visualize the products of the orchard and field of Turkestan or California served in London ten years hence with all the native freshness and taste of those freshly gathered. This means suspended animation of both enzymes and organized microorganisms. Not less interesting and romantic will be the container for these foods which I visualize as nonmetallic, transparent and nonbreakable."—CHARLES S. ASH, California Packing Corporation

Science—Supplement, June 1, 1934.

No science has progressed faster than chemistry and the one inexhaustible source of chemical raw material is the farm. More and more the chemist is showing the way toward increased markets for agricultural products. This was unknown fifteen years ago. To-day in a small way it is being done. To-morrow it should be a reality.—E. N. PETERS.

Science-Supplement.

TROPICAL LIFE understands that one of the largest makers of motor cars is busy growing his own soya beans on an extensive scale to secure regular supplies of the products of the beans for use when turning out his cars, at the rate, roughly, of (the products of) a bushel of beans per car. Casein, the principal ingredient, is used for a non-flammable substitute for celluloid or imitation ivory, the oil in the making of paints and enamels as well as for lubrication.

Thus truly nothing is wasted, for the 40 per cent or less, put aside by the motor-car maker offers an excellent concentrated food for cattle. Besides this, when harvesting you have the soya hay as well.

Tropical Life, August-September, 1934.

The Rural Lecture Caravan was on tour in Perak during the month and visited nine centres in the Kuala Kangsar, Kinta and Lower Perak Districts. Instruction was mainly confined to mouldy rot disease control and poultry husbandry, except at Sitiawan, where lectures on improved methods of copra production were included. A satisfactory amount of interest was shown in the slides and exhibits demonstrating the subjects upon which concentration was focussed. The films as usual attracted large audiences.

The Malayan Agricultural Journal, August, 1934.

This flag has not sheltered in her shade, nor fomented the destructive activities of war, but has instead protected a regime of life, industrial and constructive, through which have been communicated to us those economic activities making for the increase of wealth and hence, the material well-being which makes intellectual and moral progress possible in a nation. It is the emblem of a great modern nation that does not seize the riches created by another, but uses her energy to defend all by the work of her hands and her intelligence. DR. TRINIDAD H. PARDO DE TAVERA.

The Philippine Social Science Review, July, 1934.

COLLEGE AND ALUMNI NOTES

As an off-shoot of the vary successful Conference on Higher Education held in Manila in connection with the formal inauguration of President Bocobo the College was favored with an interesting convocation at which were present President Bocobo, Prof. Herman C. E. Liu, President, Shanghai University, Dr. Mongling Chiang, President, Peking University, Prof. Wing T. Chan, Educational Director in Lingnan University, Prof. Masanori Oshima of the Women's University, Tokyo, and Dr. Yuten Ito of Taihoku Imperial University, (Formosa), all delegates to the Conference.

Professor Oshima made a brief opening talk. Doctor Ito spoke on some points recently brought to light by some Japanese researchers on the common origin of Japanese and Filipinos. Professor Liu spoke upon what China is doing in the line of educating the rural population of China. Professor Liu is an exceptionally forceful and entertaining extemporaneous speaker. He is quite at home with the English language and obviously vitally interested in the modern educational progress of his people.

In a letter to Dr. G. O. Ocfemia dated November 29, 1934, Dr. Otto A. Reinking, temporarily located at the Biologische Reichsanstalt at Berlin-Dahlem, Germany writes:

"I was very much pleased to receive a copy of the Jubilee Number of The Philippine Agriculturist. It is well gotten up and will always be a fine remembrance for me. With best wishes... to you and all at Los Baños."

Dr. Reinking, it will be remembered, is working with Dr. H. W. Wollenweber, world authority on *Fusaria*. They are preparing a book on *Fusaria* and Fusarium diseases of plants of the world—which they expect will be published this year.

Acknowledging the receipt of the Silver Jubilee number of *The Agriculturist*, Prof. R. E. Buchanan, Director of Iowa Agricultural Experiment Station in a letter to Dr. Valente Villegas writes: "I have examined the volume with much interest. The illustrations give me a much clearer idea of the work of the College and of the experimental work.

May I extend the congratulations of our staff to you and the other Iowa State College alumni in agricultural work.

Two requests were recently received by the Department of Plant Physiology for literature on results on its work on rice. One from Dr. G. G. Gustchin of Priasoven Rice Station U. S. S. R. was received by Doctor Espino and one from Dr. K. I. Thadani of the Agricultural Research Station, Sakrand, India by Doctor Juliano.

At the request of the National Development Company, Dean Gonzalez appointed a committee to make an inspection of the Sabani Estate located in the municipality of Laur, Nueva Ecija. The committee appointed is Mr. Vicente B. Aragon, as chairman, Doctors Leon G. Gonzalez and Miguel Manresa and Mr. Enrique Bautista and

Mr. Jesus de Guzman as members. The committee made the required inspection the first week in January.

Among the recent visitors to the Department of Agronomy who were interested in the culture of cassava, coffee and cacao were Mr. E. D. Rivera of San Narciso, Zambales, Miss Adela Silva of Manila and Miss Estrella Arandilla of Jaro, Iloilo.

The Committee on Social Affairs with financial and goodwill support of faculty made December 24 a day of enjoyment instead of loneliness and homesickness for the students remaining on the Campus over the holidays. As much of the Christmas spirit as was possible was injected into the pleasure. One feature to be highly recommended was the parade of the Campus Cadet Band playing the well-loved Christmas Carols through all the principal parts of the Campus, including Forestry. It is hoped that next year a large group of students will be with the band singing the carols. Nothing so fills the heart with the Christmas spirit as the carol singing.

The whole afternoon was given to lively competitive athletic games. In the evening through the kindly generosity of Mr. Guillermo Garcia Bosque, Vice President of Theatres Supply Corporation, who gave the use of the films, there was in the Auditorium a movie showing an excellent feature, "Kit Carson over the Great Divide and two shorts."

Before the show, packages with suitable Christmas goodies were distributed. At 10:30 through arrangement with Station KZRM Radio Manila there was a half hour broadcast of Christmas music as a favor to College of Agriculture and School of Forestry. To Mrs. Pauline Crumb Smith of the KZRM staff sincere thanks are due for the fine program she arranged. It included Christmas songs by the Trinity Choir and by the Associated Glee Clubs of 1500 voices. This fine cooperation of the Theatres Supply and KZRM gave the students a delightful evening closing in ample time for Midnight Mass.

The Agronomy 13 class (course, cereals and field legumes) made an educational trip to the Central Luzon provinces from December 20 to 23 in connection with their studies on manufacture of flour, irrigation systems and on methods of harvesting, curing, threshing, storing and milling rice. The first place visited was the Tuason Flouring Mills in Manila where the students were given a short lecture on the manufacture of rice, corn and mungo flours. The three

largest irrigation projects in the Philippines, the Angat Irrigation Project in Bulacan, the Peñaranda River Irrigation Project in Peñaranda, Nueva Ecija and the Talavera River Irrigation Project in San Jose, Nueva Ecija were visited. Two large rice mills and bodegas, the Co Leco & Co. at Sta. Rosa, Nueva Ecija, and the Tansio Rice Mills and Bodega in Cabanatuan were visited to observe methods of milling and storing rice.

The class was so fortunate as to be invited to visit the famous Hacienda Bertese belonging to Representative Isauro Gabaldon at Quezon, Nueva Ecija. The system of management was clearly explained to the students by Mr. Senen Gabaldon, son of Representative Gabaldon and the present manager of the Hacienda. The students were shown around the Hacienda and were allowed to examine the farm records, for their benefit a demonstration on threshing rice with a thresher was also given on the Hacienda.

The class also visited the Maligaya Rice Station of the Bureau of Plant Industry where Mr. Felix Maramba, formerly of the Agricultural Engineering Department, of this College, gave a short lecture on the different projects of the station. The students were taken to the different parts of the station where the different varieties of rice and other farm crops are being grown. The last place visited in Nueva Ecija was the Central Luzon Agricultural School at Muñoz. All the projects of the school, both inside and outside, were visited with Mr. Nazario Sadora '23 guiding the students and giving short talks on the different projects.

Returning to College, the class passed through Pangasinan, Tarlac, Pampanga and Bulacan where they made observations on the methods of harvesting and curing rice. A short stop was made at the Paniqui Sugar Mills at Paniqui, Tarlac where they were met by Mr. Manuel Monsalud '31. And also to the Pampanga Agricultural High School at Magalang, Pampanga where Messrs. Santiago Medrana '27 and Gregorio Albino '28 met them.

INDEX

VOLUME XXIII
JUNE, 1934 TO MARCH, 1935

A

B

I

J

K

L

M

S

U

V

W

Y

Bullens

ROOM B55

POSITION

OFFICE, FACTORY & HOME REMOVALS